Structural Demand Shifts and Potential Labor Supply Responses in the New Century

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I. Introduction

It is widely recognized that inequality of labor market earnings in the United States grew dramatically in recent decades. This trend may be seen in Figure 4.1, which plots the growth of real hourly wages of U.S. workers (both male and female) by earnings percentile for the years 1973 through 2005. Over the course of more than three decades, wage growth was weak to nonexistent at the bottom of the distribution, strong at the top of the distribution, and modest at the middle. While real hourly earnings of workers in the bottom 30 percent of the earnings distribution rose by no more than 10 percentage points, earnings of workers at the 90th percentile rose by more than 40 percentage points.

What is much less widely known, however, is that this smooth, monotone growth of wage inequality is a feature of a specific time period—and that this time period has passed.[1] Figure 4.2 shows that, consistent with common perceptions, the growth of wage inequality between 1973 and 1989 *was* strikingly linear in wage percentiles, with sharp falls in real wages at the bottom of the distribution and modest increases at the top.[2] Yet, starting in the late 1980s, the growth of wages "polarized," with strong, ongoing wage growth in the top of the earnings distribution, meaning at or above the 70th percentile, and modest growth in the lower tail of the distribution, defined as at or below the 30th percentile. Notably, the portion of the wage distribution that saw the least real earnings growth between 1989 and 2005 was the "middle" group, roughly the earners between the 30th and 70th percentiles of the distribution.[3] Thus, 1973 to 1989 and 1989 to 2005 represent two distinct periods of rising

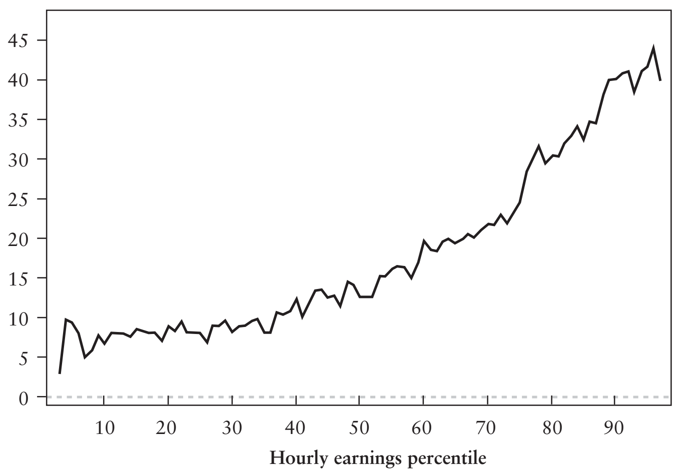

Figure 4.1
Changes in Real Log Hourly Earnings of All U.S. Workers from 1973 to 2005 by Percentile of the Hourly Earnings Distribution
Source: Current Population Survey and U.S. Census Bureau.

inequality: the first one is characterized by diverging wages throughout the distribution, and the second displays polarizing wage growth.

These two epochs are contrasted in Figure 4.3, which plots the evolution of the ratio of 90th to 50th percentile hourly earnings alongside the evolution of the ratio of 50th to 10th percentile hourly earnings.[4] The 90/50 ratio rises smoothly and secularly from 1979 to 2004. By contrast, the 50/10 ratio rises sharply from 1979 to 1987, plateaus in 1988, and then reverses course for the remainder of the time period. The divergent growth of upper- and lower-tail wage inequality in the 1980s and 1990s is also corroborated by microeconomic data on wages and total compensation from the establishment-based Employment Cost Index (see Pierce 2001). The steady growth of upper tier earnings inequality is seen in rising shares of wages paid to the top 10 and top 1 percent of U.S. earners since the late 1970s, as revealed in tax data (see Piketty and Saez 2003).

This paper evaluates the sources of the growth and then the polarization of earnings inequality in the United States, and considers these implications for the future growth of labor demand, by which we mean

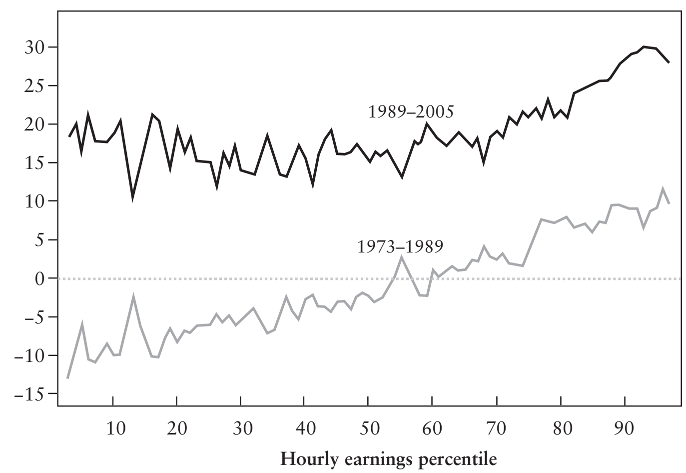

Figure 4.2
Changes in Real Log Hourly Earnings of Men and Women from 1973 to 1989 and from 1989 to 2005 by Percentile of the Hourly Earnings Distributions
Source: Current Population Survey and U.S. Census Bureau.

the demand for workers at various skill levels.[5] We begin by reviewing basic trends in earnings levels by education groups over several decades, and show how the pattern of polarization visible in Figure 4.2 is also reflected in trends in earnings by education level. We next consider whether these patterns of changing earnings by educational level can be adequately explained by canonical labor demand models of the type used by Katz and Murphy (1992); Autor, Katz, and Krueger (1998); Card and Lemieux (2001); and Acemoglu (2002), among many others. Though these models do an excellent job of explaining the evolution of U.S. income inequality to 1992, their explanatory power fares poorly thereafter, which suggests a substantial change, or structural break, in the character of labor demand over the last 15 years.

We briefly consider whether the widely discussed institutional explanations for rising U.S. wage inequality—most particularly, fluctuations in the U.S. minimum wage and the tight labor market of the 1990s—provide a sufficient alternative explanation for these same patterns. While these

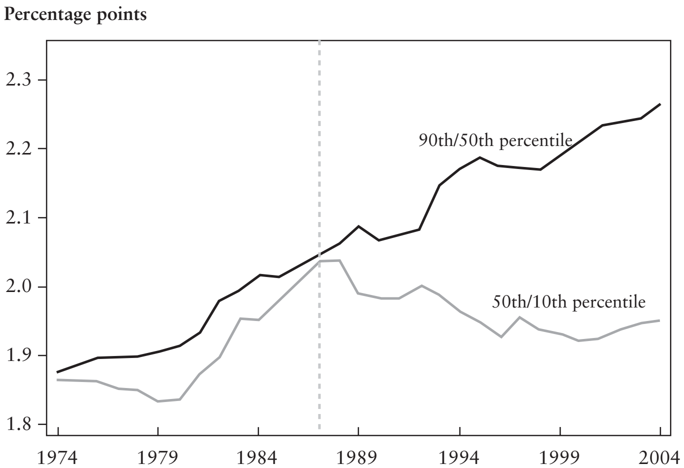

Figure 4.3
Ratios of 90th to 50th and 50th to 10th Percentile Real Hourly Earnings, 1974–2004 (Three-Year Moving Averages)
Source: Current Population Survey and U.S. Bureau of Economic Analysis.

two specific factors are likely to have contributed to rising inequality, particularly in the 1980s, neither one provides a viable explanation for the long-term secular growth of high incomes seen in the 1970s through 1990s, nor for the plateau and slight rebound of low incomes observed during the 1990s.

We next discuss how technological change and, more recently, international outsourcing, may provide a plausible, albeit still preliminary, explanation for the polarization of earnings growth. Following the conceptual model offered by Autor, Levy, and Murnane (2003), we argue that technological change (recently abetted by outsourcing) has been complementary to high-education occupations, particularly deleterious to middle-education occupations, and neither strongly complementary to nor strongly deleterious to (meaning substitutable for) low-education service occupations. A key implication of this conceptual framework is that computerization may foster a demand-driven polarization of labor market activities. Corroborating this implication, we present initial evidence that the observed polarization of earnings inequality *is* demand-

driven. Drawing on this model, we speculate on the changing shape of labor demand in the United States, which in the future we argue will be characterized by rapid growth of managerial and professional occupations *and* rapid growth of comparatively low-education service employment.

The final section of the paper focuses on three sets of research and policy issues that impinge on how the changing shape of labor demand will affect employment opportunities and earnings inequality in the United States. The first set of issues considers potential supply responses in the form of human capital investment and immigration policy. A second set considers the role of labor standards and social welfare policy in shaping the quality of future jobs, particularly service jobs. The third and final set of issues considers areas of theory and measurement needing urgent attention for improving our understanding of how changes in technology and trade will affect U.S. labor demand in the ensuing decades.

II. Measuring Earnings Inequality

To summarize the basic changes in the U.S. wage structure over the last four decades, we draw on two large and representative household data sources: the March Current Population Survey (CPS) and the combined CPS May and Outgoing Rotation Group samples. The March CPS data provide reasonably comparable data on prior year's annual earnings, weeks worked, and hours worked per week for four decades. We use the March files from 1964 to 2006, which cover earnings from 1963 to 2005, to form a sample of real weekly earnings for workers ages 16 to 64 years who participate in the labor force on a full-time, full-year (FTFY) basis, defined as working 35-plus hours per week and 40-plus weeks per year. We complement the March FTFY series data with data on hourly wages of all current labor force participants using May CPS samples for 1973 through 1978 and CPS Outgoing Rotation Group samples for 1979 through 2003 (CPS May/ORG). From these sources, we construct hourly wage data for all wage and salary workers employed during the CPS sample survey reference week.[6]

We focus on two measures of relative earnings. The first is inequality in the upper and lower halves of the wage distribution, summarized by 90-

50 and 50-10 log wage gaps, which we refer to as upper- and lower-tail inequality. These trends are depicted above in Figure 4.3. The second is "between-group" inequality, which we measure using the earnings levels and earnings differentials among workers of different educational attainments.[7] Figure 4.4 displays these earnings trends for full-time, full-year workers by educational attainment for the years 1963 to 2005.[8] In this figure, the average earnings for each educational attainment level in 1963 are normalized to zero, and subsequent data points represent the logarithmic change in earnings (approximately equal to the percentage point change) since 1963. Wage levels are indexed using the Personal Consumption Expenditure deflator, and are composition-adjusted to hold constant the gender and labor market experience of workers within each educational group at their average levels over 1963 to 2005.

Figure 4.4 reveals the four major episodes in the evolution of between-group inequality in the United States. From 1963 to 1973, real wages grew strongly for all educational groups. Since growth rates were relatively comparable across educational levels (with the exception of work-

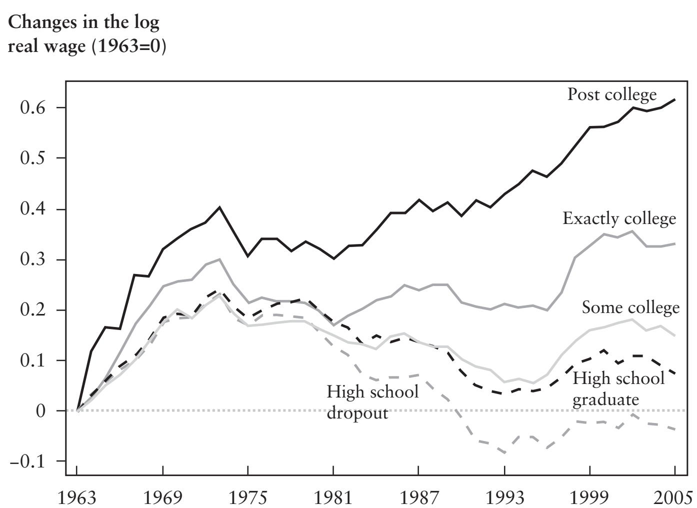

Figure 4.4
Changes in Composition-Adjusted Real Log Weekly Full-Time Wages of U.S. Men by Education, 1963–2005
Source: Current Population Survey and U.S. Bureau of Economic Analysis.

ers with a postcollege education), these sharp gains were not accompanied by a significant rise in between-group inequality. Following the 1973 oil shock, earnings levels stagnated for all educational groups, while income inequality remained largely steady. Commencing in 1979, income inequality rose rapidly even as average earnings remained stagnant. The real wages of workers with a four-year college degree or postcollege education increased significantly, while the real wages of those with a high school degree or less plummeted. Most recently, from the early 1990s forward, overall earnings levels have risen again, but this growth has been bimodal: the earnings of less educated workers (those with a high school degree or lower/less) rose modestly, the earnings of the most highly educated (those with postcollege education) rose extremely rapidly, and the earnings growth of those with some college education was comparatively weak. Thus, the polarization of *overall* earnings growth in the 1990s, as depicted in Figures 4.2 and 4.3, is reflected in a contemporaneous polarization of earnings *across* education groups.

III. Rising Inequality: The Role of Demand Shifts for College-Educated Versus Non-College-Educated Workers

To interpret the forces shaping the rise and subsequent polarization of wage inequality—and to forecast its future trajectory—it is critical to assess the degree to which shifts in labor demand are responsible for the observed patterns. In this section, we ask whether the rising wages of workers with high levels of educational attainment versus those with low levels of educational attainment can be explained by a combination of demand and supply shifts that favor more educated workers. A particularly simple and attractive formulation of this supply-demand framework posits that there are two major skill groups in the labor market, those with at least four-year college degrees and those with high school degrees. Both skill groups, termed college equivalents and high school equivalents, are in demand as employees by firms and, critically, these groups are imperfect substitutes in production. Thus, an increase in the relative supply of one group reduces its earnings relative to the other group.[9]

Figure 4.5 illustrates the intuitive appeal of this conceptual framework. In this figure, the series labeled "Log Wage Differential" plots

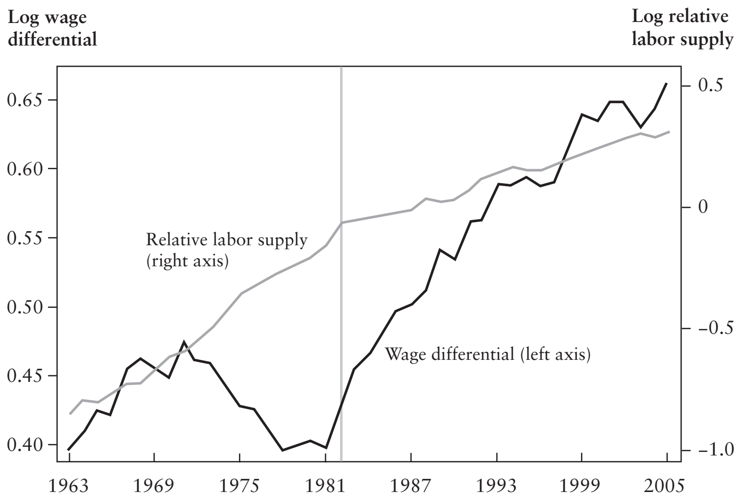

Figure 4.5
College Relative to High School Labor Supply and the College-High School Wage Differential, 1963–2005
Source: Current Population Survey.

the composition-adjusted log college/high school earnings gap for 1963 through 2005. Consistent with the more disaggregated earnings series summarized in Figure 4.4, the college/high school gap rises in the 1960s, contracts modestly in the 1970s, and then expands rapidly from 1981 forward. By 2005, the college/high school gap has attained its highest level—94 percent or 66 log points—since 1915 (see Goldin and Katz 2007). This gap is nearly double the 1963 level of 49 percent (40 log points). The second series in Figure 4.5, labeled "Log Relative Supply," depicts the evolution of the composition-adjusted supply of college-educated relative to high-school-educated workers in the same time period. This series reveals an acceleration of the growth in the relative supply of college workers in the 1970s compared to the 1960s, followed by a dramatic slowdown starting in 1982. Notably, this deceleration, caused by slowing college attainment among cohorts of youth born after 1950 (see Card and Lemieux 2000), corresponds closely with the sharp jump in the college/high school wage premium after 1981. Thus, the juxtaposition of these series suggests that fluctuations in the rate of supply growth of

college-educated workers, overlaid on secularly rising demand for college workers, may provide a reasonable summary explanation for the growth of college wage premium. Indeed, this hypothesis was famously espoused by Katz and Murphy in 1992, who found that it provided an excellent fit for trends in the college wage premium for the years 1963 to 1987, their data set's ending year.

To explore the power of this framework for more recent trends in inequality, we re-estimate the Katz-Murphy model using earnings data extended to 2005, thus going 18 more years beyond their original work. Our illustrative conceptual framework starts with a Constant Elasticity of Substitution production function for aggregate output Q with two factors, college equivalents (c) and high school equivalents (h):

(1) $Q_t = [\alpha_t(a_t N_{ct})^\rho + (1 - \alpha_t)(b_t N_{ht})^\rho]^{1/\rho}$

where N_{ct} and N_{ht} are the quantities employed of college equivalents (skilled labor) and high school equivalents (unskilled labor) in period t, a_t and b_t represent skilled and unskilled labor augmenting technological change, α_t is a time-varying technology parameter that can be interpreted as indexing the share of work activities allocated to skilled labor, and ρ is a time invariant production parameter. Skill-neutral technological improvements raise a_t and b_t by the same proportion. Skill-biased technological changes involve increases in a_t/b_t or α_t. The aggregate elasticity of substitution between college and high-school equivalents is given by $\sigma = 1/(1 - \rho)$.

Under the assumption that college and high school equivalents are paid their marginal revenue products, we can use equation (1) to solve for the ratio of marginal products of the two labor types, yielding a relationship between relative wages in year t, w_{ct}/w_{ht}, and relative supplies in year t, N_{ct}/N_{ht} given by

(2) $\ln(w_{ct}/w_{ht}) = \ln[\alpha_t/(1 - \alpha_t)] + \rho \ln(a_t/b_t)] - (1/\sigma)\ln(N_{ct}/N_{ht})$,

which can be rewritten as

(3) $\ln(w_{ct}/w_{ht}) = (1/\sigma)[D_t - \ln(N_{ct}/N_{ht})]$,

where D_t indexes relative demand shifts favoring college equivalents and is measured in log quantity units. The impact of changes in relative skill supplies on relative wages depends inversely on the magnitude of aggregate elasticity of substitution between the two skill groups. The greater is σ, the smaller the impact of shifts in relative supplies on relative wages, so the fluctuations in demand shifts (D_t) must be greater to explain any given time series of relative wages for a given time series of relative quantities. Changes in D_t can arise from (disembodied) skill-biased technological change, non-neutral changes in the relative prices or quantities of non-labor inputs, and shifts in product demand.

Following the approach of Katz and Murphy (1992), we directly estimate a version of equation (3) to explain the evolution from 1963 to 2005 of the overall log college/high school wage differential series for full-time, full-year workers from the March CPS shown in Figure 4.5. We substitute for the unobserved demand shifts D_t with a simple linear time trend. We also include an index of the log relative supply of college/high school equivalents:[10]

$$(4)\quad \ln(w_{ct}/w_{ht}) = \gamma_0 + \gamma_1 t + \gamma_2 \ln(N_{ct}/N_{ht}) + \varepsilon_t,$$

where γ_2 provides an estimate of $1/\sigma$.

Figure 4.6 plots the observed college/high school premium for years 1963 to 2005 alongside the fitted values of equation (4), generated by estimating the Katz-Murphy model for calendar years 1963 through 1987, and then extrapolating the estimates through the year 2005 based on the observed evolution of college/high school relative supply. The model implies a strong, secular growth of college/high school relative demand at the rate of about 2.6 log points annually over 1963 to 1987. Though the Katz-Murphy model is only fit to data through 1987, it does an excellent job of *forecasting* the growth of the college wage premium through 1992, thus suggesting that demand shifts favoring college-educated workers continued apace in these years. This demand growth is typically interpreted as evidence of skill-biased technological change, which refers to any introduction of a new technology, change in production methods, or change in the organization of work that increases the demand for more-skilled labor relative to less-skilled labor at fixed relative wages. Indeed, comprehensive analyses of longer time series by Autor, Katz, and Krueger (1998) and Goldin and Katz (2007) suggest that such skill-biased demand shifts have been underway for many decades—and that these shifts have accelerated in the second half of the twentieth century.

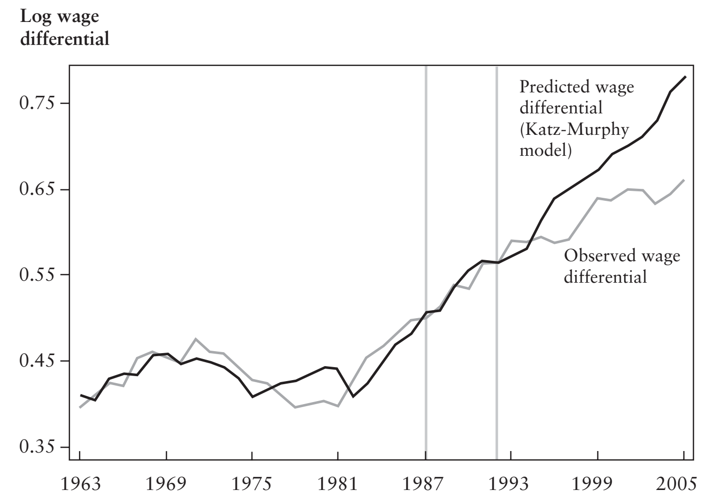

Figure 4.6
College-High School Wage Differential, 1963–2005: Observed and Predicted Values
Source: Current Population Survey.
Note: Predicted values are estimated for the years 1963–1987 and extrapolated to 2005, based on the Katz-Murphy model (Katz and Murphy 1992).

What drives these secular demand shifts? A large literature, reviewed in Katz and Autor (1999) and Katz (2000), yields two consistent findings that suggest that skill-biased technological change has played an integral role.[11] The first finding is that the relative employment of college-educated workers and non-production workers (that is, professional, managerial, and technical workers rather than line workers) has increased rapidly within detailed industries and within business establishments in the United States during the 1980s and 1990s, despite the sharp rise in the relative wages of these groups (see Dunne, Haltiwanger, and Troske 1997; Autor, Katz, and Krueger 1998). Similar patterns of within-industry increases in the proportion of skilled workers are apparent in other advanced nations (Berman, Bound, and Machin 1998; Machin and Van Reenen 1998). These findings suggest strong within-industry demand shifts favoring the more skilled, meaning more college-educated, workers.[12] Second, a wealth of quantitative and case-study evidence documents a striking correlation between the adoption of computer-based technologies (and associated organizational innovations) and the increased use of college-educated labor within detailed industries, within firms, and across plants within industries (see Doms, Dunne, and Troske 1997; Autor, Levy, and Murnane 2002; Levy and Murnane 2004; Bartel, Ichniowski, and Shaw 2007).

While this simple, demand-side explanation is appealing, this story is not entirely confirmed by the data. The Katz-Murphy model accurately predicts the ongoing growth of the college wage premium between 1987 and 1992, the model substantially *overpredicts* the growth of the college wage premium going forward from 1992. This suggests, unexpectedly, that demand shifts favoring college-educated workers have *slowed* since 1992.[13] This implied slowdown in trend demand growth in the 1990s is potentially inconsistent with a simple skill-biased technical change story that appeals to the ongoing growth of computer investments, since these investments continued rapidly throughout the 1990s, particularly with the rapid diffusion of the Internet. Why has this slowdown in demand for college-educated workers occurred?

One potential explanation for this implied slowdown is the strong cyclical labor market of the expansion of the 1990s, leading to a tight labor market that may particularly boost the earnings of workers with comparatively lower levels of educational attainment. The weakening of some labor market institutions, such as the erosion of the real value of the minimum wage since the early 1980s, might also have played a role. These hypotheses are evaluated by Autor, Katz, and Kearney (2008), however, and are found lacking in explanatory power. After accounting for the role of supply shifts, the real minimum wage and prime-age male unemployment rates provide only modest additional explanatory power for the evolution of earnings inequality, and thereby reduce the extent of the estimated slowdown in trend demand growth over the last decade.[14] These cyclical and institutional factors are insufficient to resolve the puzzle posed by slowing trend-relative demand for college-educated workers in the 1990s.[15]

A closer look at the data suggests why the simple CES model with two inputs—college and high school equivalents—fails to provide an

adequate explanation of the evolution of between-group wage inequality starting in the early 1990s. As shown in Figure 4.4, the real, composition-adjusted earnings of full-time, full-year workers at different levels of educational attainment polarized after 1987 in a manner consistent with the divergent trends in 90-50 and 50-10 inequality documented in Figure 4.3. In particular, the wage gap between males with a postcollege education and those with a high school education rose rapidly and monotonically from 1979 through 2005, increasing by 43.1 log points overall and 15.4, 15.7, and 12.0 points, respectively, between 1979–1988, 1988–1997, and 1997–2005.[16] By contrast, after increasing by 13.3 log points between 1979 and 1987, the wage gap between males with exactly a four-year college degree and those with a high school education rose comparatively slowly thereafter, by 4.5 and 9.0 log points, respectively, between 1988–1997 and 1997–2005. By implication, between 1988 and 2005, the earnings of postcollege educated males rose by 14.2 log points *more* than the earnings of males with only a four-year college degree.[17] Conversely, at the bottom of the wage distribution, the wage gap between high school graduates and high school dropouts increased steadily from 1979 and 1997, then flattened or reversed.

This pattern, in which wage gaps *within* college-educated and non-college-educated workers groups diverge, is inconsistent with the basic, two-factor CES model. In this model, the labor input of all college-educated worker subgroups is assumed to be perfectly substitutable up to a scalar multiple, and this substitution holds similarly for non-college-educated worker subgroups. Accordingly, the wage *ratio* of college-educated to postcollege-educated worker should be roughly constant, as should be the wage ratio of high school dropouts to high school graduates. This two-factor assumption fits the data rather well from 1963 to 1987. However, after 1987 the drastic rise in earnings of postcollege-educated workers relative to workers with only a four-year college degree, and the slightly increasing earnings of high school dropouts relative to high school graduates after 1997 represent significant departures from the model's assumptions. Fundamentally, the two-factor model does not accommodate a setting in which the wages of very high and very low-skilled workers rise relative to those of middle-educated workers—that is, the model does not accommodate a setting in which wage growth polarizes. We consider the sources of this polarization next, after briefly considering the role of the minimum wage in greater detail.

IV. The Elusive Role of the Minimum Wage

In contrast to our conclusions above, several other studies, including Lee (1999), Card and DiNardo (2002), and Lemieux (2006b), find that fluctuations in the U.S. minimum wage play a primary role in the rise of wage inequality since 1980. The minimum wage explanation for rising wage inequality has obvious appeal. As shown by Card and DiNardo (2002), there is a striking time series relationship between the real value of the federal minimum wage and hourly wage inequality, as measured by the 90-10 log earnings ratio. This relationship is depicted in Figure 4.7. A simple regression of the 90-10 log hourly wage gap from the May/ORG CPS for the years 1973 to 2005 on the real minimum wage yields a coefficient of –0.74 and an R-squared of 0.71. Based in part on this tight correspondence, Card and DiNardo (2002) and Lemieux (2006b) argue that much of the rise in overall and residual inequality over the last two decades may be attributed to the minimum wage.[18] In a cross state analysis of the minimum wage and wage inequality for the period 1979 to 1991, Lee (1999) reaches a similar conclusion.

A potential objection to this argument is that the majority of the rise in earnings inequality over the last two decades occurred in the upper half of the earnings distribution. Since it is not plausible that a declining minimum wage could cause large increases in upper-tail earnings inequality, this observation suggests that the minimum wage is unlikely to provide a satisfying explanation for the bulk of inequality growth. Not surprisingly, as shown in the upper panel of Figure 4.7, the real minimum wage is highly correlated with lower-tail earnings inequality between 1973 and 2005; a 1 log point rise in the minimum is associated with 0.26 log point compression in lower-tail inequality. Somewhat surprisingly, the minimum wage is also highly correlated with upper-tail inequality: a 1 log point rise in the minimum is associated with a 0.48 log point compression in upper-tail inequality; see Figure 4.7, lower panel.

Autor, Katz, and Kearney (2008) explore these relationships in greater detail by estimating a set of descriptive regressions for hourly earnings

inequality among three pairs of income percentiles, 90-10, 90-50, and 50-10, over the period dating from 1973 to 2005. In addition to the minimum wage measure used in Figure 4.7, Autor, Katz, and Kearney (2008) augment these models with a linear time trend, a measure of college/high school relative supply (calculated from the May/ORG CPS), the male prime-age unemployment rate (as a measure of labor market tightness), and in some specifications a post-1992 time trend, reflecting the estimated trend reduction in skill demand in the 1990s. The main finding from these models is that the strong relationship between the minimum wage and both upper- and lower-tail inequality is highly robust.

These patterns suggest that the time series correlation between minimum wages and income inequality is unlikely to provide causal estimates of minimum wage impacts. Indeed, the relationship between the minimum wage and upper-tail inequality is potential evidence of spurious causation. Although the decline in the real minimum wage during the 1980s likely contributed to the expansion of lower-tail inequality—particularly for women—the robust correlation of the minimum wage with upper-tail inequality suggests that other factors are at work.[19] One possibility is that federal minimum wage changes (or lack of changes) during these decades were partially a response to political pressures associated with changing labor market conditions and the costs a minimum wage increase would to impose on employers. This "political economy" story could help explain the coincidence of falling minimum wages and rising upper-tail inequality.[20]

V. Why Is Labor Demand Polarizing? The Possible Role of Technology and Outsourcing

Why, following the monotonic surge of earnings inequality from 1979 to 1987, did U.S. wage growth polarize, with a strong, persistent rise in inequality in the upper half of the distribution, and a slowing, then slight reversal of inequality, in the lower-half of the distribution? Based on the analysis discussed above, along with further evidence presented in Autor, Katz, and Kearney (2008), we conclude that neither standard supply-demand models nor conventional institutional explanations are sufficient to explain the evolution of U.S. income inequality since the late 1980s.

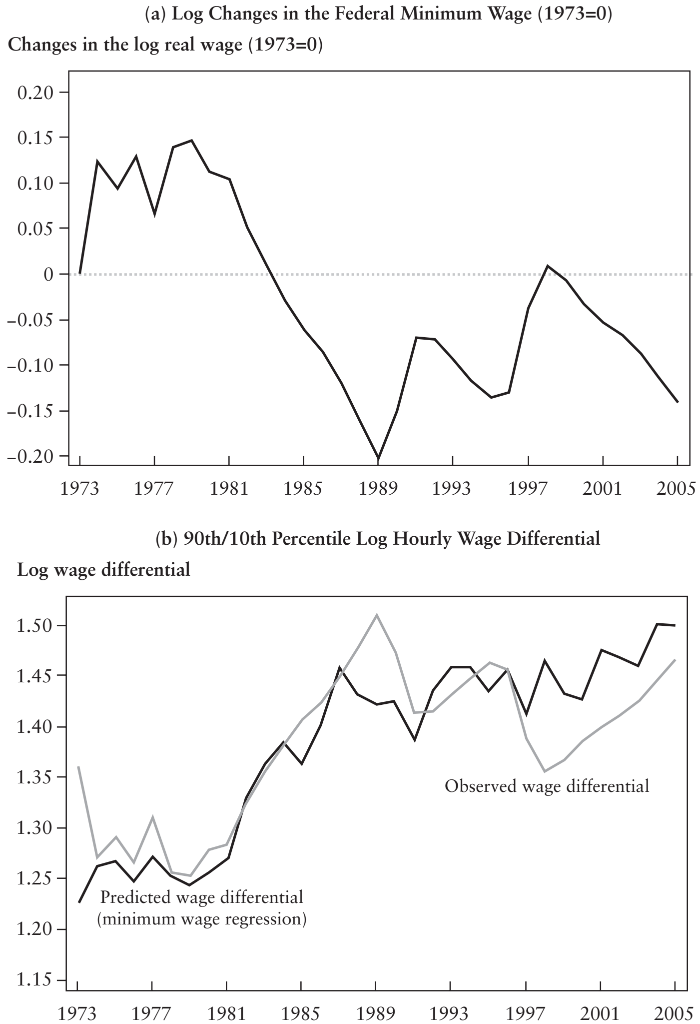

Figure 4.7

Log Hourly Wage Differentials, 1973–2005: Observed Values and Predicted Values from a Regression on the Log Real Federal Minimum Wage

Source: Current Population Survey and U.S. Bureau of Economic Analysis.

Note: Nominal minimum wages are deflated to real log values using the PCE deflator. In panel (a), the real log minimum wage measure is normalized to zero in 1973. Subsequent panels depict the observed wage gap (between the 90th and 10th percentiles, 50th and 10th percentiles, and 90th and 50th percentiles) for all hourly workers from the May and Outgoing Rotation Group Current Population Survey samples in each year plotted alongside the predicted values from separate OLS regressions of the relevant wage gap on a constant and the contemporaneous real log minimum wage.

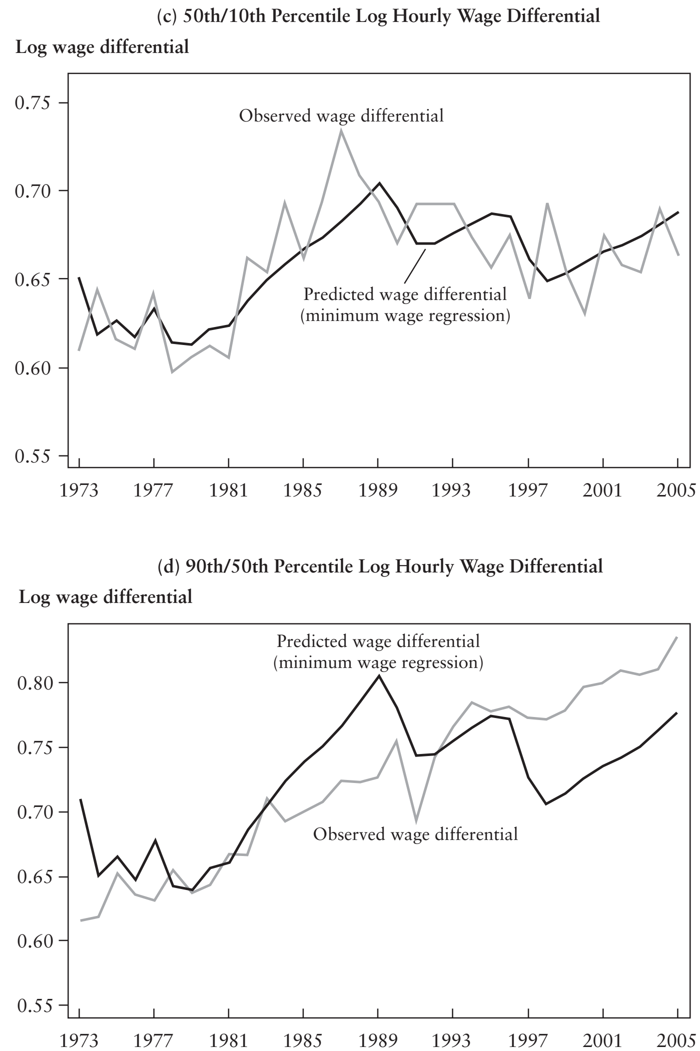

Figure 4.7 (continued)

In this section, we focus on one potentially viable hypothesis for the polarization of earnings inequality, which focuses on changing demand for job tasks, often linked to computerization and, over the longer term, outsourcing. As argued by Autor, Levy, and Murnane (2003, hereafter this article is referred to as "ALM"), and amplified by Goos and Manning (2007); Spitz-Oener (2006); Autor, Katz, and Kearney (2006); and Dustmann, Ludsteck, and Schönberg (2007), the term "skill-biased technological change" presents an inadequate description of the shifts in skill demands that were induced or abetted by the rapid price declines in computer technology over the last three decades. In the task framework proposed by ALM, computerization has non-monotone impacts on the demand for skills throughout the earnings distribution, sharply raising demand for the cognitive and interpersonal skills used by college-educated professionals and managers (termed "abstract tasks") and reducing demand for clerical and routine analytical and mechanical skills that comprised many middle-educated white collar and manufacturing production jobs (termed "routine tasks").[21] Somewhat paradoxically, computerization has probably had little direct impact on the demand for the non-routine manual skills (termed "manual tasks") used in many "low-skilled" service jobs such as health aides, security guards, hospital orderlies, janitors, and servers. Because the interpersonal and environmental adaptability demanded by these manual tasks has proven extraordinarily difficult to computerize (to date), these manual activities may in fact grow in importance as a share of labor input.[22]

The ALM framework suggests that computerization, along with complementary forces such as international outsourcing, may have raised demand for skills among higher-educated workers, depressed skill demands for middle-educated workers, and left the lower echelons of the wage distribution comparatively unscathed.[23] Goos and Manning (2007) label this process a "polarization of work," and argue that it may have contributed to a hollowing out of the wage distribution in the United Kingdom from 1975 to 2000. Spitz-Oener (2005) and Dustmann, Ludsteck, and Schönberg (2007) report a similar polarization of employment for the former West Germany during the 1979 to 1999 period.[24]

To illustrate the relevance of shifts in task demands for changes in skill demands, we link data on task intensity by occupation (information

taken from the U.S. Department of Labor's online Dictionary of Occupational Titles) to data on skill level by occupation contained in the 1980 Census. In this analysis, occupational skill level is measured by the mean years of education of an occupation's workforce (weighting workers by their annual hours worked). Figure 4.8 uses a locally weighted smoothing regression to plot task intensity by occupational skill for each of the three broad task categories above: abstract, routine, and manual tasks.[25] Task intensities are measured as percentiles of the baseline distribution of job tasks in 1960. Thus, an occupation with the median intensity of "routine" task input in 1960 would receive a score of 50. This figure shows that the intensity of abstract skill input is monotonically rising in occupational skill level (reflecting more education) and, conversely, the intensity of manual task input is falling in occupational skill level. Most

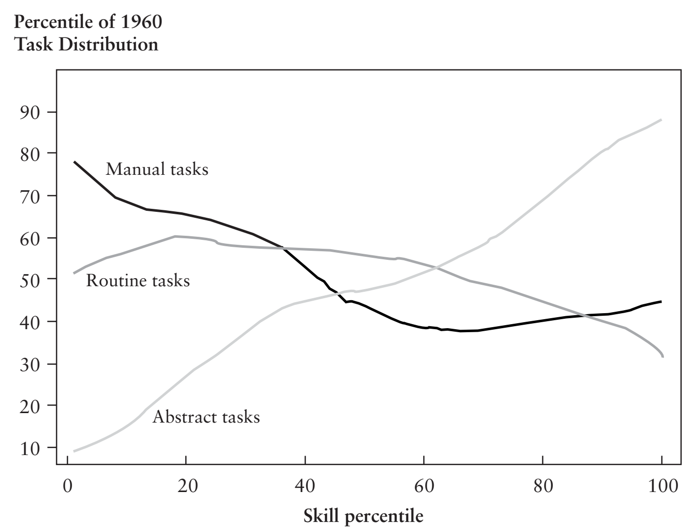

Figure 4.8
Task Intensity by Occupational Skill Percentile, Defined as Occupation's Rank (in Percentiles) in Mean Years of Education
Source: Dictionary of Occupational Titles and U.S. Census Bureau.
Note: Percentiles of the 1960 task distribution are determined using occupational task inputs defined in the Dictionary of Occupational Titles. The figure uses a locally weighted smoothing regression to calculate the plotted values.

significantly, there is a distinctly non-monotone relationship between occupational skill and routine task input. Routine task use is highest between the 20th and 60th percentiles of the skill distribution, and falls off sharply on either side of this range. This non-monotonic relationship is highly relevant because, as documented by ALM, routine task input saw the sharpest decline of all task categories over the last two decades (relative to its initial 1960 level). The substitution of information technology for routine tasks might be expected to contribute to polarization by reducing demand for middle-skill occupations relative to either high- or low-skill occupations.

An implication of the polarization hypothesis is that the twisting of the wage structure observed in recent years is, at least in part, a demand-side phenomenon, induced by rising relative demands for both high- and low-skill tasks. This implication is testable, and we provide a simple evaluation here. Following analysis for the United Kingdom in Goos and Manning (2007), we use U.S. Census data to explore how employment growth by occupation over the last two decades is related to occupational skill, as proxied by educational levels.[26] Our hypothesis is that, if the wage structure changes observed in the 1980s and 1990s are driven in substantial part by demand shifts, wage changes by earnings level and employment changes by skill level should positively covary in both decades.

To test this implication, in the upper panel of Figure 4.9 we plot the change in the share of total hours worked in the economy from 1980–1990 and 1990–2000 by occupation skill percentile, using the education-based occupational skill measure developed earlier.[27] For the decade of the 1980s, we see substantial declines in employment shares at the bottom end of the skill distribution, and observe strongly monotonic increases in employment shares as we move up the skill distribution. In contrast, employment growth in the 1990s appears to have polarized. There is rapid employment growth in highest-skill jobs (at or above the 75th percentile), a decline in the employment shares of middle-skill jobs (those at percentiles between 30 to 75), and flat or rising employment shares in the lowest-skill jobs, those in deciles one through three.

This pattern of job growth corresponds closely with the observed pattern of wage structure changes in each decade, as is shown in the lower panel of Figure 4.9. Real wage growth was essentially monotone in terms

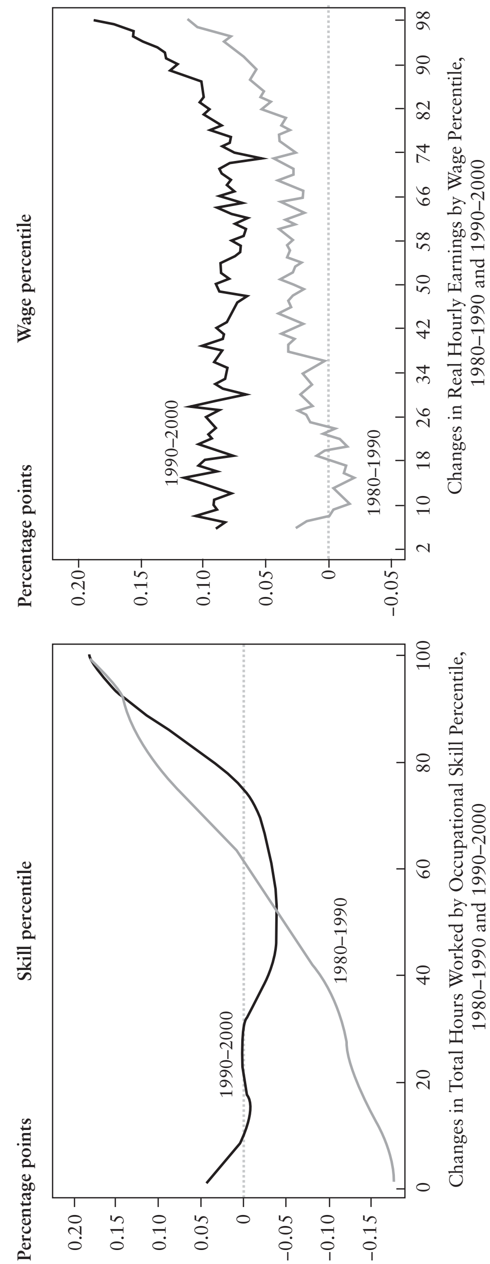

Figure 4.9
Changes in Occupational Employment Shares and Real Hourly Earnings, 1980–1990 and 1990–2000
Source: U.S. Census Bureau.
Note: Occupational skill percentile is defined as an occupation's rank (in percentile) in mean years of schooling.

of wage percentiles in the 1980s, with especially sharp wage growth above the 75th percentile and especially sharp declines below the 30th percentile. In the decade of the 1990s, however, wage growth was more U-shaped. Wage growth was stronger below the 30th percentile, and especially above the 80th percentile of the distribution, than throughout the remainder of the distribution. Thus, despite substantial differences in the evolution of inequality between the 1980s and 1990s, labor market prices and quantities (as measured by wage and skill percentiles) appear to positively covary in each decade.

To provide a slightly more rigorous assessment of this observation, we estimate a set of ordinary-least-square models of the form,

$$\Delta E_{p\tau} = \alpha_\tau + \beta_\tau \Delta \ln W_{p\tau} + \varepsilon_{p\tau}, \tag{5}$$

where changes in log employment share by skill percentile are regressed on changes in log wages by wage percentile in each decade. Here, $\Delta E_{p\tau}$ represents the change in occupational log employment share at skill percentile p in decade τ, and $\Delta \ln W_{p\tau}$ is the change in real log hourly earnings at the corresponding wage percentile in the same decade.[28] Using data for the 4th through 97th percentiles of the earnings and skill distributions (thus trimming outliers at the tails), we estimate that $\beta_\tau = 300$ ($t = 3.75$) for the 1980s, and that $\beta_\tau = 2.96$ ($t = 1.90$) for the 1990s. Thus, both the monotone rise of wage inequality in the 1980s and the polarized growth of wage inequality in the 1990s are mirrored by conformal changes in employment by skill. This finding is consistent with a demand-side explanation for observed wage changes.[29]

We have further experimented with these simple models by including linear terms in wage percentiles in addition to (or instead) of estimated wage changes by percentile. For the decade of the 1980s, we find that a linear function of wage percentiles fits the observed pattern of skilled employment growth better than does the observed change in earnings by percentile. In the 1990s, by contrast, the linear term is insignificant, and the estimate of $\beta_{90\text{–}00}$ is hardly affected by its inclusion (either in magnitude or precision). These simple models do not, of course, take into account the substitutability and complementarity among various skill groups, as measured by skill percentiles, and so lack a well-grounded production function interpretation. We nevertheless view these models

as suggestive evidence that labor demand shifts have favored low- and high-wage workers relative to middle-wage workers over the last fifteen years—a pattern that stands in contrast to the shifts in labor demand during the 1980s, which appear to have been monotonically rising in skill.

VI. The Jobs of the Future: Both "Lousy and Lovely" Jobs

There is no controversy to the contention that highly-educated professional and managerial jobs, meaning those jobs using abstract skills, will continue growing rapidly. Perhaps less recognized is the corollary implication to this proposition: that jobs demanding "non-routine manual" skills, meaning those skills not readily automated, and hence jobs requiring only low-levels of educational attainment, are likely to expand as well. In the memorable phrase used in Goos and Manning (2007) to describe the polarization of employment they found in the United Kingdom, we seem to be confronting a future labor market in which jobs are either "lovely" or "lousy." To provide some direct evidence on the relevance of this hypothesis, we look at the changing occupational structure of employment in the United States.

Table 4.1 shows the educational level and employment shares in six major occupational groups covering all U.S. employment categories: 1) managerial and professional specialties; 2) technicians, sales, and administrative support; 3) precision production, craft, and repair; 4) service occupations; 5) operators, fabricators, and laborers; and 6) farming, fishing, and forestry occupations. The category in which workers have the highest average educational level is managerial and professional specialty occupations, followed, at some distance, by technicians, sales, and administrative support. The four remaining categories—each averaging half the size of the first two—are demonstrably less education-intensive Whereas in the year 2000, high school dropouts made up 2.2 percent of employment in professional/managerial jobs and 6.7 of employment in technical, sales and administrative support jobs, they comprised 20-plus percent of employment in the four remaining categories.

As discussed by Autor and Dorn (2007), employment growth has not been uniform across these six categories. Figure 4.10 shows that managerial and professional specialty occupations—the highest skilled cat-

Table 4.1
Employment and Educational Statistics for Six Main Census Occupation Groups in 2000

	Employment Share	Median Hourly Wage	% High School Dropout	% No College	% Female	% Non-White	% Foreign Born
All Occupations	100.0	$13.58	12.1	39.3	42.1	21.6	14.2
Service Occupations	13.4	$9.40	21.3	55.1	51.3	30.8	19.7
All Occupations except Service Occupations	86.6	$14.42	10.7	36.8	40.8	20.1	13.3
Managerial and Professional Specialty Occupations	30.2	$19.23	2.2	11.4	46.5	16.2	11.8
Technicians, Sales, and Administrative Support	28.8	$12.50	6.7	35.0	58.8	20.8	11.6
Farming, Forestry, and Fishing Occupations	1.3	$7.50	33.0	67.2	14.9	20.6	22.3
Precision Production, Craft, and Repair Occupations	12.3	$14.40	19.9	60.4	8.6	18.7	14.3
Operators, Fabricators, and Laborers	14.0	$11.49	27.3	71.9	22.2	28.3	18.6

Source: Autor and Dorn (2007) calculated from Census IPUMS 2000 5 percent sample. All calculations are weighted by hours of annual labor supply and exclude those under age 18 or over age 65.

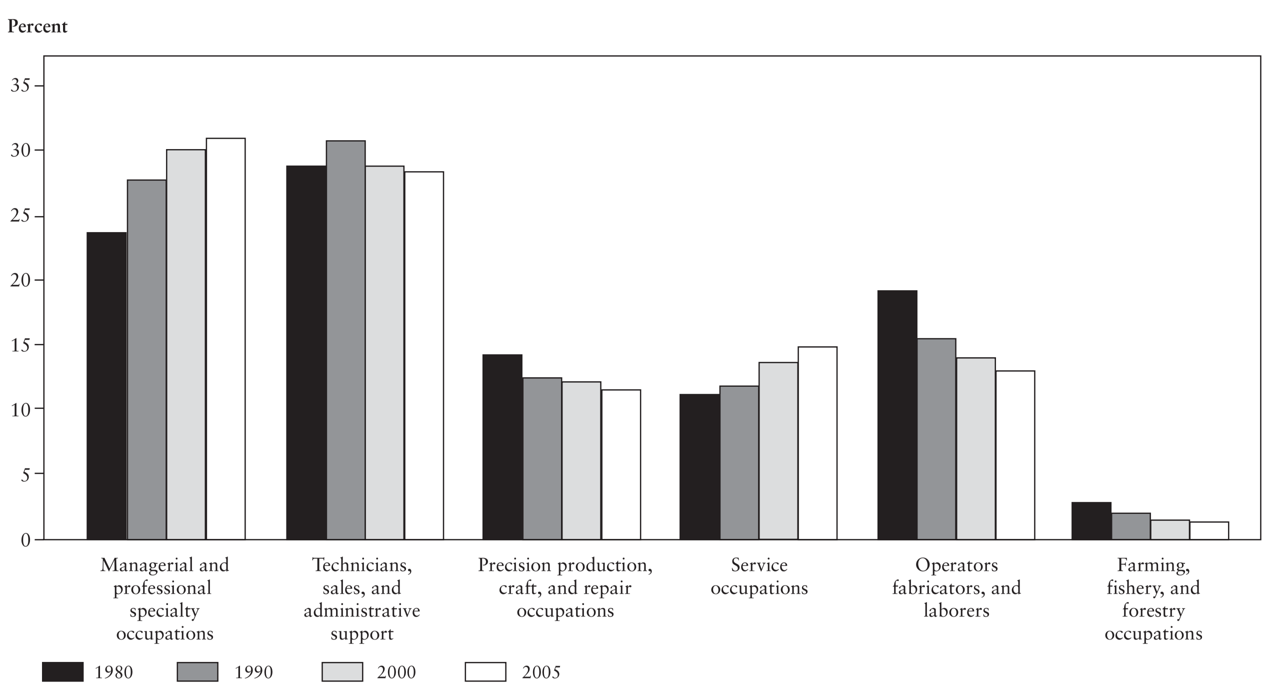

Figure 4.10
Employment Shares of Major Census Occupation Groups, 1980, 1990, 2000, and 2005
Source: U.S. Census Bureau.

egory—experienced consistent, rapid growth between 1980 and 2005, gaining 7.1 percentage points as a share of overall employment between 1980 and 2005, a 30 percent increase. By contrast, employment in the middle skill group of technical, sales and administrative support occupations showed an inverse U-shape pattern over this period, expanding in the 1980s and then contracting to below its initial 1980 level over the next 15 years; this is consistent with the growing substitution of technology for completing routine tasks. Most strikingly, employment shares in three of the four low-skill occupations fell sharply in each decade. Between 1980 and 2005, farming, forestry, and fishery occupations contracted by more than 50 percent as a share of employment, while the category comprised of operators, fabricators, and laborers contracted by 33 percent, and precision production, craft, and repair occupations contracted by 19 percent.

Standing in sharp contrast to these patterns of declining employment, however, is the experience of service occupations. Despite being among the least educated and lowest paid occupations in the U.S. economy, employment in service occupations expanded in each decade between 1980 and 2005, rising from 11.0 percent of employment in 1980 to 11.8 percent in 1990, to 13.7 percent in 2000 and to 14.9 percent in 2005. This 35 percent increase is 6 percentage points larger than the gain in employment shares of managerial and professional occupations during the same period.

What is unique about service jobs? Table 4.2 lists the major service occupations, the largest of which are: food preparation and service; health service support (a group that excludes registered nurses and other skilled medical personnel); and buildings and grounds cleaning and maintenance.[30] These are low-paying jobs; in the year 2000, 73 percent had hourly wages below the overall hourly median. From the perspective of our conceptual framework, what distinguishes these service occupations is that each is highly intensive in "non-routine manual" tasks—activities requiring interpersonal and environmental adaptability yet little in the way of formal education. These are precisely the job tasks that are difficult to automate with current technology because these jobs are non-routine *and* difficult to outsource because, in large part, the tasks involved must be produced and performed in-person in real time.

Table 4.2
Employment Statistics for Service Occupations in the Year 2000, and Growth Rates for 1980–1990 and 1990–2000

	Employment Share in 2000	Median Hourly Wage in 2000	% Female in 2000	% Non-White in 2000	% Foreign Born in 2000	% Growth 1980–90	% Growth 1990–2000
All Service Occupations	13.4	$9.40	51.3	30.8	19.7	8.5	15.8
Housekeeping, Cleaning, Laundry	0.8	$7.21	80.7	45.4	37.8	−11.0	2.5
Protective Service	2.1	$15.05	17.8	25.2	7.2	15.2	8.1
Food Preparation and Service	3.5	$7.55	53.6	31.7	25.0	8.9	11.4
Health Service Support	2.7	$9.93	73.0	31.6	15.1	5.2	64.4
Building and Grounds Cleaning and Maintenance	2.2	$9.53	19.8	32.9	25.2	10.6	−7.5
Personal Appearance	0.6	$8.65	81.4	27.4	20.5	7.1	−1.7
Child Care	0.8	$7.00	94.2	28.2	15.3	11.4	57.1
Recreation and Hospitality	0.4	$10.35	46.3	26.5	15.0	25.0	75.0
Other Personal Service	0.3	$12.02	56.2	17.3	12.3	17.2	0.0

Source: Autor and Dorn (2007), calculated from Census IPUMS 1980, 1990, and 2000 5 percent samples. All calculations are weighted by hours of annual labor supply and exclude those under age 18 or over age 65.

Employment projections from the Bureau of Labor Statistics (BLS) Employment Outlook confirm the view that low-skilled services are likely to be a major contributor to U.S. employment growth going forward. The BLS forecasts that employment in service occupations will increase by 5.3 million, or 19 percent, between 2004 and 2014.[31] The only major occupational category with greater projected growth during this time period is professional occupations, which are predicted to add 6 million jobs, a 21.2 percent increase.[32] Like all forecasts, these should be treated as tentative. Historically, the BLS has underpredicted the growing demand for professional and managerial occupations (see Bishop and Carter 1991; Freeman 2006).

It is likely that the rapid growth of service employment in the United States has multiple causes. One is the direct substitution of computerization for routine tasks, which causes the share of labor input devoted to non-routine activities to increase.[33] A second force, though of highly uncertain magnitude, is international outsourcing, which complements computerization in permitting routine tasks previously performed by domestic workers to be sourced to other locations.[34]

But these technological forces are not the only drivers of this increased demand. The aging of the U.S. population contributes to the growth of health services support occupations—and this contribution will become more important going forward. Supply-side factors may also be important. Recent work by Cortes (2006) demonstrates that influxes of low-skilled immigrants into major American cities causes the market prices of non-traded, low-skill intensive services to fall and consumption of these services to rise. Thus, the rapid growth of service employment is also partly attributable to U.S. immigration policy.

A final, relatively unstudied, factor potentially contributing to the growth of service employment is the rise of income inequality itself. Household consumption of services appears to be highly income elastic (Mazzolari and Ragusa 2007). This makes it plausible that the strong, secular rise in the earnings share of high-income households over almost three decades has increased final demand for services (see Piketty and Saez 2003; Autor, Katz, and Kearney 2008). Preliminary evidence supporting this hypothesis is offered by Autor and Dorn (2007) and Mazzolari and Ragusa (2007), who find that service employment growth in the United States has been greatest in the metropolitan areas where income inequality has increased the most. Given that the rise of high incomes shows no signs of abating, this force may stimulate additional demand for low-education, in-person services.

VII. Possible Labor Supply Responses: Human Capital Policy and Immigration Policy

Proceeding on the view that U.S. employment growth will be concentrated at the tails—in other words, in occupations requiring either high or low levels of education—how might labor supply respond? Because other papers in this volume treat this question in great detail, I offer only brief remarks on this issue, focusing on topics where policy is likely to have particular leverage.[35]

A first point of paramount economic importance is that the returns to human capital investments are currently extremely high. While some research has highlighted the fact that the college wage differential plateaued in the early 1990s, this observation needs to be placed in appropriate context. Even in the late 1990s, the college wage differential stood at a near-historic level (see Goldin and Katz 2007). And, as indicated by Figure 4.4, there was a further pickup in the pure college/high school premium after 1999. Moreover, the wage differential associated with postcollege educational returns has risen rapidly and near-continuously from 1980 to the present. Thus, postsecondary education appears to be an excellent investment.

Responding to this price signal, college enrollment of U.S. youth has risen considerably since the premium to earning a four-year college degree began its historic rise in the early 1980s. After falling slightly between 1970 and 1980, the fraction of 20 to 24 year-olds enrolled in post-secondary education rose from 35.9 percent in 1980, to 42.7 percent in 1990, to 44.7 percent in 2000, and 49.3 in 2005 (U.S. Department of Education 2007). College completion rates have not risen commensurately, however. Bound, Lovenheim, and Turner (2007) report that from 1970 forward, the share of youth obtaining the equivalent of a four-year college degree by age 23 rose only slightly for cohorts completing high school.[36] Simultaneously, the completion rate among those attending college fell by

10 percent, and the share completing a degree within four years (among degree completers) fell by 20 percent. Although some increase in the college non-completion rate is to be expected as the fraction of students enrolling in college rises, these statistics suggest that there may be room to improve the outcomes of these initial investments in a college education. Indeed, despite having led the world in high school and college completion for most of the twentieth century, U.S. young adults are now in the middle of the pack in the Organization for Economic Cooperation and Development (OECD) in terms of educational attainment (see OECD 2006; Goldin and Katz 2007).

There is ongoing debate about the degree to which financial constraints hinder college matriculation among U.S. youth. There is little doubt, however, that the gap in college attendance rates when gauged by parental income, race, and ethnicity remain large and may have potentially widened over the last 25 years (see Ellwood and Kane 2000; Heckman and Carneiro 2002).[37] Considerable evidence shows that reductions in college costs (due to tuition reductions or financial aid) greatly increase college attendance for youths from moderate income families (see Dynarski 2002; Kane 1999) and even affect the postcollege occupational choices of graduates of elite universities (see Rothstein and Rouse 2007). It is therefore abundantly clear that college costs have a substantial impact on the college-going decisions and career choices of young adults. Moreover, the economic returns to college attendance for youth from moderate income families appear to be at least as large as those for more advantaged attendees (Card 2001). Thus, there appears a solid case for reducing the financial barriers to college attendance for students from low and moderate income U.S. families.

As has been stressed by many researchers, generous college financing is not sufficient for college success. Students who do not receive adequate human capital investments early in life may gain less from later educational investments (see Heckman and Lochner 2000). Most evidence suggests large returns from early childhood educational interventions (see Currie 2001; Anderson 2007). Thus, efforts to improve college attainment among U.S. students need to commence well before students approach college-going age.[38]

In addition to fostering college attendance by U.S. residents, a critical policy lever for increasing the supply of highly educated workers for the

American workforce is attracting skilled students of all nationalities to U.S. colleges and universities. In 2003, 573,000 foreign students were enrolled in U.S. institutions of higher education, an 84 percent increase from the 1980 level (U.S. Department of Education 2005, Table 408). While these numbers appear sizable, the share of foreign students attending U.S. higher educational institutions is small: 2.6 percent in 1980 and 3.4 percent in 2003.[39] Foreign student enrollment brings many of the world's most talented individuals to the United States. A substantial fraction of these students will ultimately remain in the United States and contribute to U.S. invention and economic growth. To the extent that foreign students return to their home countries following their studies, one suspects that many will maintain positive economic—as well as political and cultural—interactions with the United States. Thus, the United States maximizes the return on its leadership role in higher education by producing talent and by attracting it from all parts of the world.

Foreign students enrolled in American universities are heavily concentrated in graduate- and doctoral-level study, particularly in science, technology, engineering, and mathematics (STEM). In the year 2000, foreign students received between 25 and 55 percent of all doctorates awarded by U.S. universities in the key STEM fields of electrical engineering, physics, chemistry and biology. The growth of foreign students enrolled in U.S. graduate degree programs has raised concerns that the wages of native-born Americans are adversely impacted by the influx of foreign students (see Borjas 2006). Though this is an economically sound argument, this concern strikes me as somewhat misplaced given the high and rising earnings of highly-educated workers in the United States—particularly those with graduate degrees. If the relatively abundant supply of foreign students to STEM fields serves to buffer the ongoing growth of wage inequality in the upper half of the U.S. earnings distribution, this may arguably be viewed as an additional benefit. U.S. inequality would almost surely be higher and rising more rapidly at the top if we had to rely more heavily on home-grown talent.

Closely related to the enrollment of foreign students into U.S. universities is the entry of skilled migrants into the U.S. labor force. Though the United States has many of the world's leading universities, the majority of the world's highly educated workers are produced outside of the United

States. Freeman (2006) estimates that the U.S. fraction of Ph.D.s trained relative to total world output will have fallen from about 50 percent in the early 1970s to a projected level of 15 percent in 2010. The growing cadre of highly-educated workers produced outside the United States provides one mechanism for addressing potential skill shortages. As Freeman (2006, p. 10) observes:

> During the 1990s' rapid growth of the U.S. economy, the country greatly increased its employment of scientists and engineers. It did so despite fairly constant numbers of graduates in these fields among citizens or permanent residents and without markedly raising the salaries of these workers… The United States was able to meet increased demands for scientists and engineers without huge increases in salaries by "importing" foreign born specialists in these areas. Some of the foreign born obtained their education in the United States and remained to work in the country. But most of those with B.S. degrees and roughly half of those with higher degrees graduated overseas and came to fill jobs. If the U.S. economy demands more highly skilled workers in the period of projected slow labor force growth, it should be able to increase supplies by admitting more immigrants in areas with rising labor demand, as it did in the 1990s.

This example underscores that, should the United States ultimately face a skill shortage as the baby boom generation retires, this shortage will be a consequence of political choice as a much as demographic destiny. So long as the United States is perceived by educated citizens worldwide as a land of abundant opportunity, it will be able to attract foreign talent to meet domestic labor demand.

In recent years, U.S. immigration policy has been responsive to these demands. The H1-B Visa Program allows U.S. employers to temporarily hire skilled foreigners who have the educational equivalent of a U.S. bachelor's degree. Prior to the mid-1990s, the H1-B quota stood at 65,000 visas per year. During the "dot-com" boom, Congress increased the quota to 115,000 in 1998 and then again to 195,000 in the year 2000. The quota dropped back to 90,000 in 2004, however, and is currently coming under economic pressure. The entire quota of H1-B visas for fiscal year 2007 was exhausted within a span of less than two months. It remains to be seen whether the cap will be lifted again soon.

Over the longer term, it appears possible (though highly uncertain) that the United States will move to a skills-based immigration system. The Secure Borders, Economic Opportunity and Immigration Reform

Act, which was hotly debated though ultimately rejected by Congress in 2007, would have prioritized access to U.S. visa applicants according to their educational levels, family ties, age, English language proficiency, and applicants' occupations. Of special note, priority would have been given to workers in "in-demand" occupations. While the virtues and drawbacks of such a system are too complex to adequately address here, two points deserve note. First, the notion of weighting applicants' skills in visa allocation decisions has merit. Second, accurately forecasting what skills and occupations will be "in demand" is generally not something government statistical agencies are able to predict with high reliability (see Freeman 2006). In the existing H1-B Visa Program, by contrast, employers identify and sponsor individual visa candidates. While this process is time- and resource-intensive, it does give employers a strong incentive to sponsor workers who possess particularly valuable skills. Thus, there may be efficiencies in this highly firm-level determination process. Commenting on the immigration reform act current before Congress in 2007, Lowell Sachs of Sun Microsystems opines (quoted in Broache 2007):

> The best the government can hope to do is select a pool of generically potentially qualified candidates, whereas a company knowing exactly what it needs, exactly what skills and exactly what kind of individual can best deliver is going to be far better able to make the right match… What happens if I'm interested in finding a brain surgeon and I've got a bunch of people to pick from, a pediatrician over here, a podiatrist over here, but no brain surgeon?

As this quotation highlights, it is not clear that the U.S. Congress is a better judge of the skill needs of the U.S. economy than are the U.S. employers who, under the H1-B program, hand-select individual foreign workers to meet specific skill needs.

VIII. Job Quality in the Services Occupations

There is, in my view, a solid case for meeting rising demand for professional and technical occupations, in part by importing postsecondary students and highly-trained foreign workers. The same arguments are less persuasive when applied to the demand for low-educated, in-person service workers. Unlike the earnings of four-year college graduates, wages of high school graduates and dropouts—those most likely to perform service jobs—have fared poorly over the last three decades. Autor, Katz, and Kearney (2008) estimate that real wage growth for workers with high school diplomas and lower educational attainment levels was negative between 1979 and 1995, and only modestly positive from 1995 to 2005. Facilitating increased immigration of competing worker groups appears unlikely to improve this situation.[40] Moreover, while a case can be made that high-skilled workers generate positive human capital externalities—thus making high-skilled immigration a "public good" (see Moretti 2004a and 2004b)—this argument does not apply to low-skilled immigrants.[41] Finally, it is often argued that if the United States does not import high-skilled labor, high-skilled jobs will follow the workers to where they reside. This argument clearly is not relevant for low-skill, in-person services, since the provision of these services is primarily non-tradable. In sum, rising U.S. demand for low-skilled services does not represent an economic problem that demands a policy solution. Indeed, a significant benefit of such an upward demand shift is that it is likely to increase the earnings of less-educated workers.[42]

Even given rising demand for service sector jobs, labor supply to services occupations, however, may be sufficiently elastic that wages stay low. Median real hourly wages in service jobs were \$8.99 in 1980, \$8.76 in 1990, and \$9.40 in 2000. These hourly wage rates imply annual, full-time earnings of under \$20,000 per year; but of course, many service jobs do not provide full-time, full-year earnings.[43] This income level readily exceeds the poverty threshold for the year 2000 of \$17,500 for a family comprised of two adults and two dependent children. Yet \$20,000 is probably an inadequate income for families to make optimal investments in childrearing and education. Echoing the concerns above regarding college attainment and early life preparedness, it appears a legitimate concern that the ongoing polarization of earnings levels among U.S. households will ultimately serve to thwart economic mobility among subsequent generations. While the impact of current economic inequality on future mobility cannot be judged until decades after the die is cast, it is clear from the current vantage point that a substantial reduction in mobility would be inimical to the U.S. ideal of meritocracy and equal opportunity.[44] Accordingly, policies that ensure access to excellent educa-

tion and healthcare for all U.S. families serve in part as a precautionary investment for maintaining economic mobility in the next generation.

There are two primary means to improve the economic conditions of workers in low-skilled service jobs. One way is through transfers and other social supports. For example, the Earned Income Tax Credit has substantially raised labor force participation and earnings of single mothers (see Meyer and Rosenbaum 2001). Programs such as Medicare, Head Start, and the federal Pell grant program provide health insurance, support early childhood educational investments, and reduce the cost of postsecondary education for low-income households. Such programs could be expanded and improved to provide additional assistance to childrearing families. A significant downside risk to such social policies, however, is that these programs are vulnerable to the vicissitudes of budgetary pressures and political sentiments.[45] Transfer programs that do not create a broad constituency of middle- and upper-income beneficiaries are, over the long run, probably less likely to survive.

An alternative means to improve economic conditions of workers in low-skilled service jobs is to "professionalize" these occupations to provide better services and thus command higher wages. Occupational standards and licensing are one means to accomplish this objective. Labor unions are another. The evidence on the efficiency of such steps is decidedly mixed. Kleiner's comprehensive 2005 study of occupational licensing in the United States concludes that professional licensing has primarily served to restrict competition without improving the quality of the services provided. DiNardo and Lee (2004) find that new private sector labor unions certified in the 1980s and 1990s have had little economic impact—positive or negative—on the earnings of newly unionized employees or on the profitability of newly unionized firms. Thus, despite the intellectual appeal of improving wages and performance quality in service occupations, the specific steps to accomplish this objective are not immediately evident, at least to me.

IX. International Outsourcing: A Force of Unknown Magnitude

More than any issue discussed above, there is vast uncertainty about the degree to which international outsourcing of jobs will ultimately affect domestic labor demand in the United States. At present, most quantitative assessments of the potential impacts of outsourcing are highly preliminary or impressionistic (see Kletzer 2006; Blinder 2007).[46] Theoretical work has also produced somewhat mixed projections on possible labor demand impacts (see Antràs, Garicano, and Rossi-Hansberg 2006a and 2006b; Grossman and Rossi-Hansberg, forthcoming). In my assessment, a safe conclusion is that outsourcing will increase the returns to "knowledge work," both by raising demand for scarce managerial and problem-solving talent, and by increasing the returns on intellectual property developed in advanced economies. Outsourcing will not directly substitute for performing in-person services. Moreover, the income gains accruing to the highly skilled might stimulate additional demand for such lower-level services occupations. Beyond this conjecture, there is little predictive certainty. The possibility appears remote that outsourcing will ultimately displace as large a share of domestic white collar work as international trade and technological change did to decrease domestic demand for blue collar manufacturing work. But then again, the possibility that manufacturing would ultimately employ less than 15 percent of the U.S. workforce in 2000, even while 42 percent of U.S. consumer spending was devoted to purchasing goods, must also have seemed remote several decades earlier (U.S. Congressional Budget Office 2004).

The profound uncertainty about the potential for the international outsourcing of jobs to affect domestic labor demand should stimulate much additional research on this topic. A key factor hindering research has been lack of measurement. Unlike trade in goods, trade in labor services is at an extremely primitive stage of measurement. A first priority for U.S. statistical agencies should be extensive data collection to assess the extent of international outsourcing and to document the nature of tasks currently being outsourced. Yet trade in services will always be more difficult to capture and quantify than trade in goods. Just as productivity measurement has become more uncertain as U.S. economic activity has moved from a concentration on manufacturing to services, tracking trade flows will become increasingly challenging as trade in services takes its place alongside trade in goods as an increasingly important source of U.S. economic activity.

X. Conclusion

Viewed from the perspective of the 1980s, the rapid, monotone rise of wage inequality appeared to presage an era of ever-increasing demand for skills, with rising incomes for the highly-educated workers and falling incomes for everyone else. Fortunately, this vision has not yet come to pass. The secular demand increases favoring more educated workers appear to have been less rapid in the 1990s and early 2000s than from the 1960s to the 1980s. Overall wage inequality continued growing from 1990 to 2005, but at a slower pace than in the 1980s. Rather than spreading continuously, wage growth polarized after 1987, with persistent increases in inequality in the upper half of the income distribution and slow or reversing inequality trends in the lower-half of the distribution.

Demand-side forces have played a key role in shaping structural changes in U.S. wages during the inequality surge of the 1980s, and the polarization that followed. In the 1980s, during which wage growth was essentially monotone in terms of skills, employment shares in the highest-educated and highest-paid occupations expanded substantially, while employment shares in the lowest-skill occupations contracted. During the subsequent decade—in which earnings growth polarized—employment shares in very low- and very high-skill occupations increased, while employment shares in moderately skilled occupations contracted. The roughly parallel movement of earnings and employment growth in each decade suggests that demand-side forces have been central to these patterns of wage changes.

Following Autor, Levy, and Murnane (2003) and Goos and Manning (2007), we argue that these patterns may in part be explained by a richer version of the skill-biased technical change hypothesis, which posits that information technology complements highly educated workers engaged in abstract tasks, substitutes for moderately educated workers performing routine tasks, and has less impact on low-skilled workers performing manual tasks. Extrapolating from these trends, we forecast (perhaps unwisely) an ongoing growth of demand for both professional and managerial jobs requiring high levels of educational attainment, and for low-skilled in-person service jobs—tasks that are difficult to either automate or outsource, but do not require more than a high school education.

Given slowing U.S. population growth and decelerating rates of educational attainment, it is natural for the United States to look to developing and developed countries as a source of supply for future employment growth. In the case of highly educated workers, we view such efforts as sound. Attracting skilled residents to the United States, either as students or workers, is likely to raise wealth and improve the quality of life for a large number of U.S. residents. As a secondary benefit, increased skilled migration to the United States may temper the ongoing rise of upper-tail earnings inequality. These same arguments appear less compelling when applied to the immigration of low-skilled workers. Wages of low-skilled U.S. workers have been stagnant for most of the past 30 years. If labor demand is indeed rising for low-skilled, in-person services occupations, this may give a long overdue boost to earnings for these groups—a welcome development for economic mobility and social cohesion in the United States.

Though it seems banal to end a research summary with a call for further research, this bromide seems less self-serving than usual in the current context. Due to rapid economic development in Asia and improvements in computer and communications technology, international trade and outsourcing appear poised to become important determinants of U.S. domestic labor demand. Yet we have little knowledge of the scope, magnitude, speed, or even direction with which these forces will impact skill demands and earnings distributions in the United States and in other advanced economies. Devising innovative and rigorous means to measure and evaluate the impacts of these evolving forces of globalization on inequality and economic well-being constitutes a significant agenda item for further research in this field.

■ *I am grateful to Jared Bernstein and Gary Burtless for insightful comments and suggestions. I am intellectually indebted to coauthors David Dorn, Lawrence Katz, Melissa Kearney, Alan Krueger, Frank Levy, and Richard Murnane for the main themes and conclusions of this paper.*

Notes

1. This observation was, to my knowledge, first offered by Mishel, Bernstein, and Boushey (2002).

2. The Current Population Survey and Census of Populations data analyzed here do not cover the top several percentiles of the earnings distribution where the most dramatic increases in real earnings have occurred during the last three decades (see Piketty and Saez 2003). Including these top percentiles would, consistent with our discussion, reveal even greater growth at the top throughout the years studied, but this inclusion would not qualitatively change our conclusions about income inequality.

3. It bears note, however, that all percentiles of the distribution fared better in the second half of the time period (1989 through 2005) than in the first half (1973 through 1989), reflecting the considerable acceleration of U.S. productivity growth from the mid-1990s forward.

4. These series are smoothed using three-year moving averages. Thus, the data point labeled 2004 is the average of the values for 2003, 2004, and 2005.

5. I use the term "we" throughout the paper because the material in this paper draws heavily on work I performed jointly with David Dorn, Frank Levy, Lawrence Katz, Melissa Kearney, Alan Krueger, and Richard Murnane.

6. Details of the samples and data processing methods used for these data series are provided in Autor, Katz, and Kearney (2008).

7. We do not discuss inequality of earnings residuals (that is, the unexplained component of wage variance). For recent work on this topic, see Lemieux (2006b) and Autor, Katz, and Kearney (2005 and 2008).

8. For this figure, we use the full time period of 1963 to 2005 (in contrast to Figures 4.1 through 4.3) because reliable measures of average earnings levels extending back to 1963 are available from the March Current Population Survey. By contrast, trends in earnings distribution (such as the 90/50 and 50/10) are more precisely measured using the CPS May/ORG data (Lemieux 2006b), which only extend back to 1973.

9. For previous implementations of such a model, see Katz and Murphy (1992); Autor, Katz, and Krueger (1998); Katz and Autor (1999); Card and Lemieux (2001); and Acemoglu (2002), among others.

10. We use a standard measure of college/non-college relative supply calculated in "efficiency units" to adjust for changes in labor force composition by gender and experience groups.

11. Skill-biased technological change refers to any introduction of a new technology, change in production methods, or change in the organization of work that increases the demand for more-skilled labor relative to less-skilled labor at fixed relative wages.

12. Foreign outsourcing of less-skilled jobs is another possible explanation for this pattern (Feenstra and Hanson 1999). But large within-industry shifts toward more skilled workers are pervasive even in sectors with little or no observed foreign outsourcing activity. Foreign outsourcing appears likely to become increasingly important, however.

13. Less restrictive variants of this model estimated in Autor, Katz, and Kearney (2008) also imply that trend demand growth for college relative to non-college workers slowed in the early 1990s. Autor, Katz, and Krueger (1998) and Card and DiNardo (2002) reach a similar conclusion.

14. In contrast to the findings of Autor, Katz, and Kearney (2008), analyses by Bartik (2001) and Bernstein and Baker (2003) find that a low unemployment rate differentially raises earnings in low relative to high wage deciles, thus compressing wage inequality. While a resolution of these conflicting conclusions is beyond the scope of this paper, this issue merits further study.

15. The direct effects of union decline on U.S. wage inequality growth also appear to be modest. Card, Lemieux, and Riddell (2003) find that falling unionization explains about 14 percent of the growth of male wage variance from 1973 to 2001 (in models allowing for skill group differences in the impact of unions), with an even smaller union effect for the growth of female wage variance.

16. For females, earnings growth between 1988 and 2005 among postcollege-educated workers was substantially greater than for college-only-educated workers, but the pattern was reversed for the 1979–1988 period.

17. Lemieux (2006a) documents the rapid, ongoing rise in the wage return to college and postcollege education. He estimates that more than two-thirds of the rise in wage inequality between 1973 and 2005 is explained by the growing return to postsecondary education.

18. Lemieux (2006b) focuses on the tight fit between the real minimum wage and residual wage variance for men and women from 1973 to 2003. We also find greater time series explanatory power of the real minimum wage for residual wage inequality measures than for actual wage inequality measures. This is puzzling for the minimum wage hypothesis, since the minimum wage should "bite" more for actual low wage workers than for residual low wage workers.

19. Lee (1999) also noted a puzzling relationship between the "effective" state minimum wage (the log difference between the state median and the state minimum) and upper-tail inequality. Opposite to the simple time-series regressions above, Lee finds in a cross-state analysis that increases in the effective state minimum wage appear to *reduce* upper-tail inequality, both for males and for the pooled-gender distribution. This result led him to advise caution in causally attributing trends in male and pooled-gender earnings inequality to the minimum wage.

20. In a similar vein, Acemoglu, Aghion, and Violante (2001) argue that the decline in union penetration in the United States and the United Kingdom is partly explained by changing skill demands that reduced the viability of rent-sharing bargains between high and low skill workers. Furthermore, the direct effects of union decline on U.S. wage inequality growth appear to be modest. Card, Lemieux, and Riddell (2003) find that falling unionization explains about 14 percent of the growth of male wage variance from 1973 to 2001 (in models allowing for skill group differences in the impact of unions), with an even smaller union effect for the growth of female wage variance.

21. A related earlier model along these lines is developed in Juhn (1994).

22. See Levy and Murnane (2004) for numerous paradigmatic examples. The fact that computerization causes manual tasks to grow as a share of labor input may be understood as a form of Baumol's disease—that is, the tendency for advanced economies to devote an ever-rising share of resources to labor-intensive sectors characterized by slow productivity growth, such as education and health care, while sectors with rapid productivity growth (such as manufacturing or farming) ultimately require fewer resources to meet consumer demand.

23. Welch (2000) and Weinberg (2000) argue that these technical changes are particularly likely to have been favorable to demand for female labor.

24. Acemoglu (1999) offers an alternative theory of job polarization based on endogenous changes in production techniques as a response to a rise in the availability of skilled labor.

25. The task intensity data are constructed by matching Census 1980 data by occupation and gender with task measures from the Dictionary of Occupational Titles (DOT). Task intensities by occupational skill percentile are plotted using a locally weighted smoothing regression with bandwidth 0.5 (meaning, one-half of one percentile). Details on the processing and matching of DOT task measures to occupations are given in Autor, Levy, and Murnane (2003). The abstract task category we use in Figure 4.10 is the arithmetic average of ALM's "non-routine cognitive/analytic" and "non-routine cognitive/interactive" category and, similarly, our routine task category is the average of ALM's "routine manual" and "routine cognitive" categories. Our manual category is equivalent to ALM's "non-routine manual" category.

26. Autor, Katz, and Kearney (2006) present a similar analysis using Census data for changes in occupational employment and CPS May/ORG data for changes in wage levels by earnings percentile. In the present analysis, we use exclusively Census data covering the same time periods.

27. We employ a consistent set of occupation codes developed by Meyers and Osborne (2005) for Census years 1980, 1990 and 2000. We use a locally weighted smoothing regression (bandwidth 0.8 with 100 observations) to fit the relationship between decadal growth in occupational employment share and occupations' initial skill percentile in the 1980 skill distribution.

28. In contrast to the upper panel of Figure 4.9, we use raw changes in employment shares by occupational wage percentile as the dependent variable, rather than smoothed changes. If instead we were to use smoothed changes, these would not affect the point estimates by much, but would suggest a misleadingly high degree of precision in the estimation.

29. Notably, this pattern appears inconsistent with the hypothesis that a declining minimum wage played a leading role in the expansion of lower-tail inequality in the 1980s. A decline in a binding wage floor should have lead to a (modest) rise in low-wage employment rather than a sharp contraction.

30. It is critical to distinguish service *occupations*, a relatively narrow group of low-educational level occupations comprising 13.4 percent of employment in 2000 (author's calculation from Census IPUMS), from the *service sector*, a very broad category of industries ranging from healthcare to communications to real estate, and comprising 81 percent of non-farm employment in 2000 (www.bls.gov).

31. The service employment measure used by the Bureau of Labor Statistics Occupational Outlook indicates a service employment share that is several percentage points higher that our calculations (17.7 percent versus 13.4 percent). The discrepancy stems from three factors: unlike our calculations based on household data from the Census Bureau, the BLS numbers use Current Employment Statistics (CES) which, as an establishment survey, double-counts workers who hold multiple jobs; our Census-based numbers are weighted by hours of labor supply, and so part-time jobs (common in service occupations) are weighted down whereas the CES data count all jobs equally. Our Census calculations exclude workers younger than 18 years of age, whereas the CES data include workers aged 16 years and above. The service occupation in which the Census and CES data are most divergent is in Food Preparation and Service, where our data show a 3.5 percent employment share and the CES data show a 7.4 percent employment share. Despite these discrepancies in levels, we have no reason to believe that the qualitative employment trends in the Census and CES data differ.

32. The BLS category of professional occupations excludes managerial occupations, and so is more disaggregated than the Census category of professional and managerial occupations. Combined growth in professional and managerial jobs is projected at 8.2 million jobs, or 18.8 percent.

33. Though computerization appears far more complementary to abstract tasks than non-routine manual tasks, our framework implies that computerization is a *relative* complement to all non-routine tasks (meaning, relative to routine tasks).

34. Though in many respects computerization and outsourcing appear to have similar implications for the domestic organization of work (Levy and Murnane 2006), one important difference is that there is an important subset of non-routine manual tasks that are not readily computerized but can be easily outsourced—for example, call center operations or back office manual tasks, including data entry and hand-processing of bill and check images (see Autor, Levy, and Murnane 2002). However, neither outsourcing nor computerization appears a close substitute for the in-persons tasks performed by service occupations (see Blinder 2007).

35. DeLong, Goldin, and Katz (2003) provide a thoughtful, extended discussion of policies to improve U.S. human capital investment.

36. This reflects both a high non-completion rate and an increased time to degree. Thus, the share of youth obtaining the equivalent of a four-year college degree by age 28 has risen significantly more than the share of youth obtaining the degree by 23.

37. See Heckman and Krueger (2004) for a comprehensive debate.

38. See also Heckman and Krueger (2004).

39. Denominators for these calculations come from U.S. Department of Education (2005, Table 170).

40. There is heated debate about the extent to which low-skilled immigration depresses native wages (see Borjas 2003; Card 2005; Goldin and Katz 2007). Recent evidence suggests that because the jobs of many low-skilled immigrants are heavily concentrated in "manual" tasks such as cleaning, cooking, and construction, they do not directly compete with most native-born workers, including low-skilled Americans who typically have a comparative advantage in English language communication tasks (Cortes 2007; Peri and Sparber 2007).

41. Acemoglu and Angrist (2001) provide a strong test of human capital externalities and find that they are weak or nonexistent.

42. Freeman (2006, p. 20) compellingly states this case: "If firms demand more labor than workers supply due to a reduced growth of supply, should not a country that relies extensively on unfettered markets allow those markets to raise the price of labor, just as it allowed them to reduce the pay of many in recent decades?"

43. Autor and Dorn (2007) report that the median hourly wage in service jobs was between 63 and 65 percent of the median hourly wage in non-service jobs in 1970, 1980, and 1990. Accounting for differences in full-compensation (including health insurance, vacation and sick leave) among high and low-wage workers (as in Pierce 2001) would enlarge this gap.

44. Recent research by Kopczuk, Saez, and Song (2007) finds little change in mobility over the course of a career among U.S. cohorts born between 1920 and 1950. However, these data do not speak to economic mobility across generations, in particular, how likely it is that children from low-income households reach higher echelons of the earnings distribution during their careers.

45. For example, the State Children's Health Insurance Program (SCHIP), enacted in 1997, has significantly increased the health insurance coverage rate of children from low-income households (Lo Sasso and Buchmueller 2004). SCHIP is a block grant program with fixed annual funding levels, however, and SCHIP outlays have not kept pace with population increase or the rising cost of healthcare. Absent a significant policy change, the number of program beneficiaries will have to decline. The U.S. minimum wage provides another example of a politically vulnerable policy instrument for raising earnings of low-skill workers.

46. See Hsieh and Woo (2005) for a rigorous assessment of the impact of outsourcing to China on the Hong Kong labor market.

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Comments on "Structural Demand Shifts and Potential Labor Supply Responses in the New Century" by David H. Autor

Jared Bernstein

Introduction

David Autor has written an insightful and admirable paper, which in important ways updates economists' thinking about one of the more important questions in labor economics: what is the relationship between skill demands, technological change, and wage inequality?

I'll stress the insights from the paper below, but what's admirable about its contribution? Well, as J.M. Keynes famously said when confronted with accusations regarding shifts in his analysis: "When my information changes, I change my opinion. What do you do, sir?" A healthy debate regarding the impact of skill-biased technological change has simmered among economists for a few years now, and some of us believed that the trends in the wage data did not support conventional wisdom. With this paper, building on his earlier work, Autor agrees with this contrarian assessment, and his more nuanced view of the issue is both gratifying and interesting.[1]

Below, I offer some objections to the plasticity with which Autor treats the concept of skill-biased technological change. One has the sense that he and his fellow authors remained wedded to this concept and loathe to let it go, so they've morphed the definition in ways that may strike some as stretching the concept to the breaking point. Also, in the course of this review, I question a) whether the original construction of skill-biased technological change provided an adequate description of the trends observed in wage inequality, and b) whether Autor's new interpretation is sufficient to explain more recent relative wage trends, such as those that prevailed in the latter 1990s or over the 2000s. But for those of us who have been skeptical of skill-biased technological change as the dominant explanatory factor in the growth of wage inequality in recent decades, Autor's evolving views are a welcome point of departure.

Motivation: That Pesky Trend in the 50/10 Wage Percentiles

As Autor shows in his Figure 4.2, the character of hourly wage inequality in the United States has changed over time. In the 1970s and 1980s, the wage distribution was fanning out largely monotonically: as your wage level went up, so did your wage growth. The top income groups pulled away from the middle; the middle income groups pulled away from the groups at the bottom of the wage distribution. Over the 1990s, however, growth rates were much more comparable at the middle and the bottom of the distribution. In fact, depending on which end points you choose, there was even some compression of the 50/10 ratio since the mid-to-late 1980s, especially for men.

Larry Mishel and I viewed this change as quite important, and thus focus on it in various editions of *The State of Working America*, in part because the compression of the 50/10 ratio raises questions about the economist's most popular answer for the "why" of growing wage inequality: skill-biased technological change. Among others (see Howell and Wolff 1992, Handel 2000, and Card and Dinardo 2002), we wondered why the skill demands of the workplace in the 1990s, a period of very deep, if not downright bubbly, technological capital deepening, would be more complementary to low-wage workers than had been the case in earlier years.

It seemed to us then, and still does now, that if skill-biased technological change were the main perpetrator of higher wage inequality, relative wage trends should look more like Autor's Figure 4.2, bottom line, than this figure's top line. Autor, in an earlier paper written with Levy and Murnane (2001), analyzes occupations from the perspective of skill content and tasks, and asks whether those tasks are complementary or substitutable to computer technology. In that paper, they raise the hypothesis that the skill content of recent technological change, particularly regarding the impact of computers on skill demands, may not generate the monotonic trends in relative wages that a basic skill-biased technological change hypothesis predicts.

With this paper, as with Autor, Katz, and Kearney (2006), Autor further develops a different version of skill-biased technological change, which is, as he puts it, "a richer version of the skill-biased technical change hypothesis, which posits that information technology complements highly educated workers engaged in abstract tasks, substitutes for moderately educated workers performing routine tasks, and has less impact on low-skilled workers performing manual tasks."

Two Questions

Autor's new view raises two questions. First, does the theory that Autor and his co-authors have been developing comport with the data in a lasting manner? That is, given a) his earlier research findings suggesting non-monotonic demand impacts, and b) the fact that the relative wage data trends failed to support the old view, Autor came up with an interesting and plausible explanation that fits the part of the data for which the old view did not. But if the new view fails to fit the further evolution of wage inequality, Autor and his coauthors will be forced to invent an even "richer version of the skill-biased technological change hypothesis." Going down that path can lead to "ad hockery" and, while spinning of lots of interesting analysis, an enriched explanation is unlikely to provide analysts and policymakers with a reliable sense as to the determinants of wage inequality's growth.

If that does indeed turn out to be the case, as I suspect it might (supporting evidence to follow), many would be compelled to conclude that skill-biased technological change, an obviously important theory in ways I describe below, is insufficient to explain the path of wage inequality. This is the second big question that this paper raises: is skill-biased technological change the right horse to bet on in the race to explain the evolution of wage inequality in our economy, or for that matter, any economy?

Let us first examine this second question, regarding the usefulness of skill-biased technological change as a framework for explaining and understanding wage inequality. All economists recognize that technology tends to boost labor demand for those workers whose skills are complementary to that technology (and, conversely, reduce demand for the technology's substitutes). And the long-term reality of capital skill complementarity is also an obvious feature of our labor market. It is the main reason why we can double the share of four-year college graduates, as we have done over the past 30 years, yet maintain their unemployment rate at frictional levels (typically at around 2 percent, per year).

But whether technology and human skills are complements is not the question being asked in this literature. The question asked is whether the extent of this complementarity has increased in a manner that would explain the pattern of wage inequality observed over the past few decades. As Mishel and I view it in a series of papers from the latter 1990s (some co-authored with John Schmitt), the key question was whether skill-biased technological change had accelerated to such a degree that it could explain the acceleration in wage inequality.[2]

In statistical analysis, we tested for the acceleration of skill-biased technological change by regressing changes in wage inequality across industries on measures of capital investment associated with technology, and allowing the coefficients on those variables to change over time. We found no consistent evidence to support the notion that skill-biased technological change and its impact on wage inequality had accelerated.

Interestingly, we found evidence against accelerating skill demands in work by economists closely tied to the skill-biased technological change story. Katz, in various papers [most recent in work with Goldin (2008)], uses a simple CES production function model of the labor market to create indexes of labor supply and demand by skill level, stretching back many decades. Note that these models examine just one dimension of wage inequality: that existing between college-educated and non-college-educated workers. So-called residual wage inequality—the part not explained by the usual regressors in human capital models—is not part of this analysis (analysis like that in Autor's Figure 4.2 captures both residual and "between group" aspects of wage inequality).

The Katz/Goldin model assumes that changes in relative wages (skilled relative to unskilled workers, or college-educated to noncollege-educated workers) are a function of shifting demand and supplies of different types of labor, the degree to which relative supply changes effect relative wages (the substitution elasticity),[3] and technological progress.

For our purposes in evaluating the utility of skill-biased technological change and the case for accelerating wage inequality, the relevant outputs from the model are changes in relative demand for skills across decades.

If unmet skill demands are accelerating, meaning these are unmet by increasing skill supplies, the result will be accelerating relative wages, the pace of which is partly determined in the model by the degree to which relative skill-changes map onto relative wages through the substitution elasticity. All else equal, a larger substitution elasticity will diminish the growth of relative wages, because employers can more easily substitute away from more expensive workers.

For points I turn to next, it is important to recognize that the demand index is a residual. This is important for our alternative story, since we and others argue that there's more than demand embedded in that term. In fact, any nonsupply factor—tighter job markets or lower minimum wages—that affects relative wages gets subsumed under demand here, a critique we return to below. The top panel in Table 4.3 just reprints Goldin and Katz's table, showing that that relative wages grew most quickly in the 1980s, in fact more quickly than in any decade since 1940. The second column, relative supply growth, shows the 1970s was a decade when the share of college-educated workers grew quickly, leading to a compression in the relative wage. Since then, relative skill supplies have increased more slowly, especially in the 2000s.

But our focus is on the demand column, shown in panel B. Some authors simply interpret the positive values in this column as evidence of skill-biased technological change driving up relative demand, and thus see this as the key determinant of the between-education group part of wage inequality. But our model argues that unless these decadal demand indexes are accelerating, these are insufficient to explain the acceleration in wage inequality over these years. It is the second derivative that matters, not the first.

And, in fact, the demand index shows quite a significant deceleration over much—but not all—of the last few decades. This deceleration seems really quite revealing. According to this simple but plausible and widely accepted model of the labor market, the rate of change in relative demand for skills was slower in the 1990s than the 1980s, and slower still in the 2000s, at least through 2005.

In fact, compared to the 1980s, demand for skills in the 2000s (through 2005) grew 3.6 log points per year more slowly. This decline seems particularly remarkable when we consider the dissemination of computer-

Table 4.3
The College Wage Premium, Supply and Demand: 1940–2005 (Annual Percent Changes)

Period	Relative Wage	Relative Supply	Relative Demand
1940–50	–1.86	2.35	–0.69
1950–60	0.83	2.91	4.28
1960–70	0.69	2.55	3.69
1970–80	–0.74	4.99	3.77
1980–90	1.51	2.53	5.01
1990–2000	0.58	2.03	2.98
2000–05	0.34	0.89	1.42

Panel B: Deceleration in Relative Demand

1960s over 50s	–0.59
1970s over 60s	0.08
1980s over 70s	1.24
1990s over 80s	–2.03
2000s over 90s	–1.56

Source: Author's analysis of Goldin and Katz (2007), Table 1, using their preferred subsition elasticity of 1.64 (implying that a 10 percent increase in the relative supply of college graduates lowers the college premium by 6.1 percent (1/.61 = 1.64)).

ization and information technology in general since the 1980s. Surely, the spread of information technology has accelerated. The literature explaining the post-1995 acceleration in productivity growth is, in fact, quite clear on this point: the spread of computers and information technology explains most of productivity's acceleration.[4] In this climate, if skill-biased technological change were truly a critical determinant of relative wage trends by education level, would we not expect to see a sharp acceleration of relative demand? Instead, the model yields the opposite finding.

Other authors, such as Handel, Howell, and Wolfe (see various citations in references) had similar findings, noting that the timing of information technology's capital deepening did not match the changes in wage

inequality such that skill-biased technological change would be a likely determinant. Card and DiNardo (2002) derived various tests of the skill-biased technological change (SBTC) hypothesis, and they too found little supporting evidence: "we conclude that the SBTC hypothesis is not very helpful in understanding the myriad shifts in the structure of wages that have occurred over the past three decades."

So if skill-biased technological change is not the reason, what has been the main driver of wage inequality over these years? Our work has found that there is no smoking gun, no single factor that explains more than half of the growth in wage inequality. Instead, there appear to be many perpetrators, including high unemployment, the sharp expansion of unbalanced international trade, the decline in the real value of the minimum wage, and the decline in unions. Many of these factors fit within an "institutional" framework, and are very compellingly discussed in Levy and Temin's recent paper (2007), an analysis all the more fascinating since Levy's arguments used to be squarely in the skill-biased technological change camp. Along with Temin, Levy now writes:

> [T]he current trend toward greater inequality in America is primarily the result of a change in economic policy that took place in the late 1970s and early 1980s. The stability in income equality where wages rose with national productivity for a generation after the Second World War was the result of policies that began in the Great Depression with the New Deal and were amplified by both public and private actions after the war. This stability was not the result of a natural economy; it was the result of policies designed to promote it (41–42).

As Levy and Temin stress, it's not the case that skill-biased technological change is not important, it's that a) wage differentials are often moved by changes in institutional arrangements favoring one class of worker over another, and b) skill-biased technological change has been a fairly smooth, ongoing dynamic in our economy, consistently driving up employers' skill demands. But the institutional context within which skill-biased technological change occurs is highly determinative of relative wage outcomes.

In the interest of honest, full disclosure, there's no smoking gun for the institutional explanations either. Solid research casts doubt on skill-biased technological change and much work, including our analysis in many editions of *The State of Working America*, confirms the important influences of institutional forces on both absolute and relative wages. But

Autor and his co-authors would be well within their rights to point out that our evidence is also limited. We can point to various studies showing that declining union membership explains 10–20 percent of the increase in wage inequality, with international trade and the impact of the minimum wage each also contributing about the same percentage. But, as Autor notes (see his note 14) there is not enough convincing work on these causes either.[5]

In the next section, I explore the first question raised above: is Autor's newer model likely to offer a more reliable interpretation of the factors behind rising wage inequality?

As in Autor, Katz, and Kearney (2006), Autor's analysis is based on the shifts in employment by occupation, along with the educational composition of the occupations over time. Occupations constitute a legitimate source of variation in this type of work, since it is widely assumed that occupational demands necessarily embody technological change.

Autor's key figure supporting this analysis is Figure 4.9, panel A, which contrasts the monotonic pattern of occupation skill demands of the 1980s with the more U-shaped pattern of the 1990s. The significant accomplishment here bears remark: Autor has crafted a model which explains the changing pattern of wage inequality over the 1980–2000 period. Whether it is legitimate to call it skill-biased technological change is another matter, as I discussed above and elaborate upon in the conclusion. But this is laudable, interesting work that advances our understanding of the labor market.

But is it built to last? Is Autor's model telling us something important about the causal factors behind wage inequality—providing actionable intelligence, as the saying goes—that we can count on continuing in a way that should inform policy? Or is this model simply mapping relative wage trends onto occupations in a way that will change again when the relative wage trends shift again?

To test this, I derived a simple (too simple?), "poor man's AKK" (that's Autor, Katz, Kearney, where this model first appeared) model of occupational employment, weighted by hours and wages.[6] Sophistication-wise, my method is a mere shadow of Autor's, but my results for the 1980s and 1990s roughly match his; see Figure 4.11 for my 1980s version, which, due to a coding change, only goes from 1984–1989. My Figure 4.12

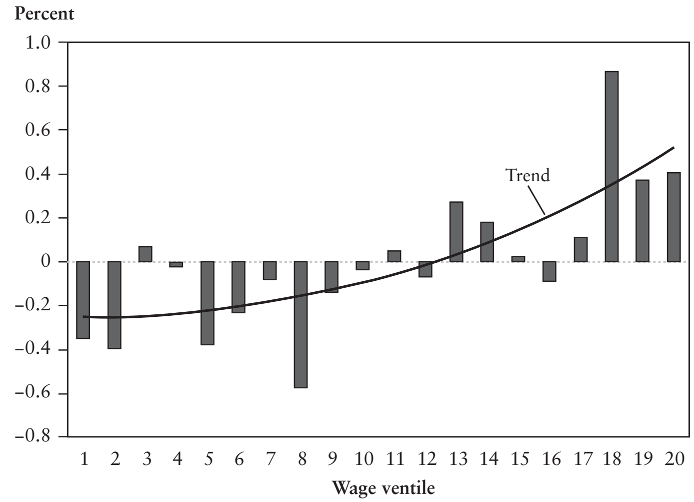

Figure 4.11
Change in Occupational Employment Shares by Wage Ventile, 1984–1989
Source: Current Population Survey.
Note: Calculation method loosely based on Autor, Katz, and Kearney (2006).

roughly reflects the polarization the Autor finds, but my results only find evidence for this in the years 1989–1995. That's because much work at Economic Policy Institute has found that the latter 1990s were a very unique period for wage inequality, as the first full employment job market in decades gave a lift to U.S. workers' bargaining power.

Given that important dynamic, I plotted the latter 1990s separately in Figure 4.13, and these seem to revert back to the earlier, more monotonic pattern. This is quite an interesting finding, in that we know relative wages were compressing between middle- and low-wage workers over this period, yet the model shows a pattern of relative demand much like that of the 1980s.

Finally, I plot the 2000s through 2006 in Figure 4.14. This decade (so far) takes on more polarizating characteristics, although one could also view this change as showing weak or negative skill demands throughout most of the skill distribution, except at the very top, possibly due to the uniquely weak job creation that prevailed over this period.

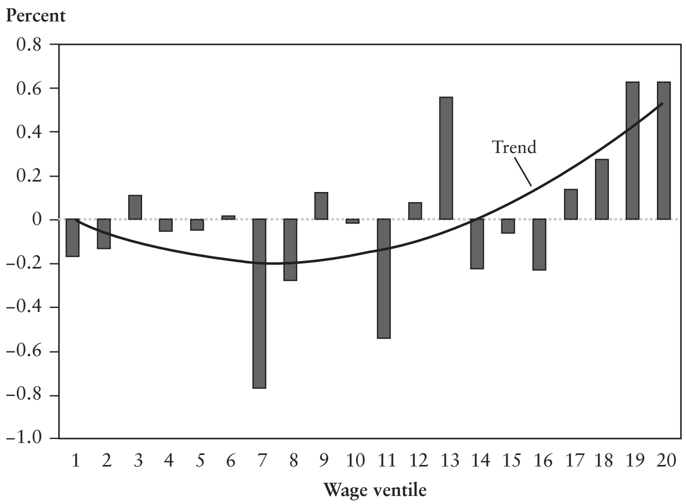

Figure 4.12
Change in Occupational Employment Shares by Wage Ventile, 1989–1995
Source: Current Population Survey.
Note: Calculation method loosely based on Autor, Katz, and Kearney (2006).

Based on the differences in our methods, this exercise by no means establishes a claim that Autor is wrong. But if his model's method really yields quite different results regarding the nature of skill demands over relatively short time periods, we need to wonder what it is really telling us. If the full employment of the latter 1990s raised the bargaining power of less-skilled workers enough to move these curves around, as my work suggests, then we do not want to conflate that change with a shift in the nature of skill-biased technological change.

I thus encourage Autor to apply his method to these other time periods, including the 2000s, to see if and how the results change over different time periods.

A second and final critique of Autor's method relates to the underlying elasticities implied by the work. The movements in the occupational index in a given decade are actually very small compared to the movements in relative wages. The 50/10 ratio falls by about .10 percentage points over the 1990–2000 period. Autor's Figure 4.9 reveals that the demand at the median fell about 0.0005 points, while demand at the low

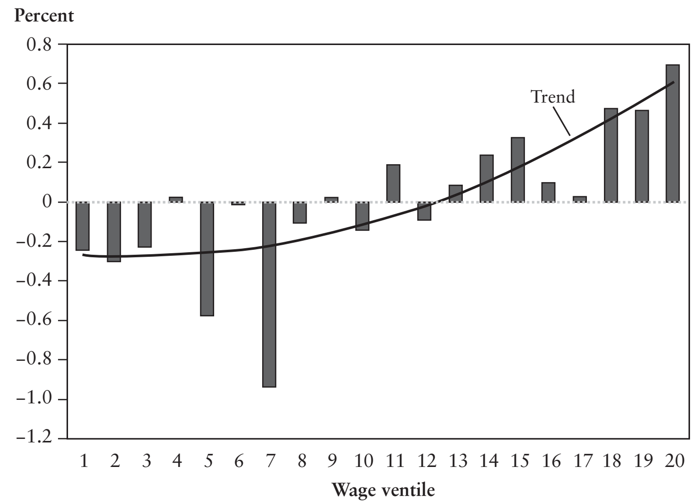

Figure 4.13
Change in Occupational Employment Shares by Wage Ventile, 1995–2000
Source: Current Population Survey.
Note: Calculation method loosely based on Autor, Katz, and Kearney (2006).

end rose about the same absolute amount. It seems unlikely that such a small shift in the occupational shares could really be the major factor driving relative wage trends of this magnitude.

As Autor has pointed out to me in a private conversation, the Autor, Katz, and Kearney model does not measure underlying shifts in supply and demand, along with relevant elasticities, as does the Katz model featured in Table 1. Instead, the model by Autor, Katz, and Kearney is driven by, in Autor's words, "realized prices and quantities," meaning the occupational and wage outcomes of an implicit labor demand and supply model that is a lot more complicated than the simple, two-skill Katz version. Underlying this implicit model is a rich set of elasticities regarding the ease with which employers can substitute different types of workers over a broad range of tasks—tasks which, unlike levels of educational attainment, are not necessarily exogenous.[7]

All of which leads one to conclude that Autor, Katz, and Kearney's model may be telling a small part of the story of shifts in relative skill/labor demand. Other factors must be playing an important role as well,

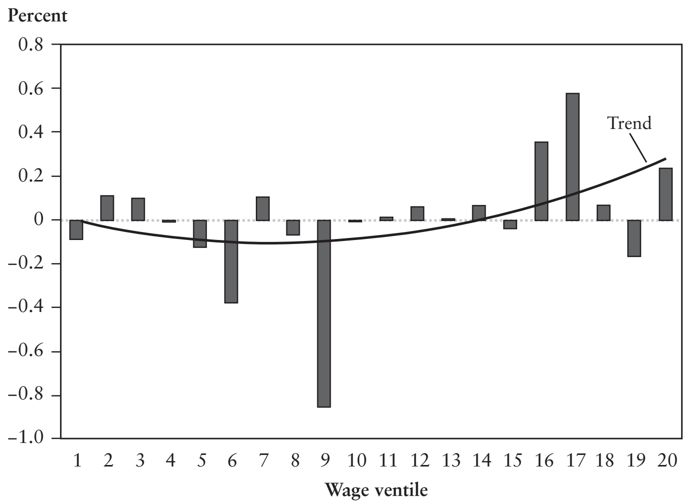

Figure 4.14
Change in Occupational Employment Shares by Wage Ventile, 2000–2006
Source: Current Population Survey.
Note: Calculation method loosely based on Autor, Katz, and Kearney (2006).

a point that I suspect Autor, an economist with an open mind and a demonstrable interest in a wide range of causes, would agree with.

Conclusion

Though I have not pulled any punches in expressing the difficulty that I and others have had in assigning a primary role to skill-biased technological change in the wage inequality debate, I still find that this paper represents a useful contribution to that debate. Autor does what good economists should do: when the old model stops working, you build a new one. One can raise concerns, as I do, as to whether the new one has any more explanatory power than the old one, outside of a specific time period, perhaps a relatively short period—he says the 1990s; I say the early 1990s—wherein it fits the data. In this regard, I hope and expect Autor to keep testing whether his polarization model continues to fit the trends in relative wages.

One final policy point: I don't think Autor (or Autor, Katz, and Kearney, for that matter) should refer to the pattern of relative demand they discover in the 1990s as skill-biased technological change. For that label to apply, technology must be monotonically biased toward skilled workers and against unskilled ones. In their new co-authored work, skill is biased toward the high end, and—perhaps to a lesser extent, but still—toward the low end.

Words matter. And the hurly-burly world of Washington, DC economic policy—the world I travel in—sustains little in the way of subtle discourse. Among DC policy makers, skill-biased technological change translates into the notion that employers' skill demands continue to shift hard against non-college-educated workers. As they envision it, the shift is absolutely monotonic; there's little room, I fear, for the notion that "skill bias" as Autor now understands it doesn't really mean skill bias as they understand it.

Autor could explain that the concept of skill-biased technological change now means a bias in favor of high- and low-end workers and a bias against middle-wage workers. That's what he's trying to establish in this paper, and he makes the case. But why insist on calling it skill bias? The policy implications are significant. If you believe in the traditional skill-biased technological change story, you're prone to think exclusively in terms of education and job training. If you instead think in terms of Autor's concept of skill-biased technological change, along with those critical skill-enhancement policies, you also recognize that demand for less-skilled jobs is strong and will remain so. And that leads economic policymakers to worry about the quality of the jobs available to the American workforce, not just the quality of the labor supply.

As I noted, Keynes would have liked this paper—a very fine compliment indeed. I urge Autor and his co-authors to continue testing this model as new trends form to see if it consistently describes the evolving patterns in relative wages. I also urge them to keep looking for other explanations that may have less to do with skill biases and technology, and more to do with bargaining power, full employment, and institutional forces within which a full and complete concept of skill-biased technological change plays out.

Notes

1. These new views on the impact of skill-biased technological change on wage inequality appeared in an earlier paper of which Autor was a co-author. See Autor, Katz, and Kearney (2006).

2. See, for example, Mishel and Bernstein (1998).

3. That is, how would an increase in the supply of less-skilled workers affect the demand for more-skilled workers? If substitution between these two groups is a simple matter for employers, then the falling relative price of less-skilled workers would induce employers to use more of them. But if skill requirements are such that employers cannot easily substitute less-skilled for more skilled workers, then the decline in relative price will have less impact of changes in employment.

4. Oliner and Sichel (2000).

5. Autor, Katz, and Kearney are very much aware of these institutional forces and test the impacts of unemployment and minimum wages. As Autor notes (note 14), they don't find much, but their analysis is fairly cursory, as they include both the minimum wage and the national unemployment rate (male, prime age) in a reduced-form, time series model with relative wages by education as the dependent variable. More detailed work, such as that cited by Autor in the aforementioned note, taps both geographical variation and examines the impact of tight labor markets on wages at various deciles, and these analyses reveal a greater impact.

6. Using Current Population Survey data, I calculated hours-weighted occupation employment shares (using three-digit codes) and rank them by their average wage level over the time period in question. I then calculate the changes in these shares between the two periods. Next, I find the ventile cutpoints in the cumulative distribution of these changes, and plot them, along with a polynomial curve.

7. Unlike quasi-fixed education levels, tasks that workers undertake can change quickly in response to relatively prices (i.e., the wages associated with the task). In the model underlying Autor's recent work (meaning Autor,Katz, and Kearney, 2006), workers reallocate time from routine to non-routine tasks as the price of routine tasks declines, so such changes are endogenous to price changes.

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Comments on “Structural Demand Shifts and Potential Labor Supply Responses in the New Century” by David H. Autor

Gary Burtless

David Autor has written a clear, judicious, and even-handed survey of recent evidence on shifts in demand for U.S. labor, particularly the shifts that affect American employers’ demand for skills. Since Autor is himself a major contributor to this literature, it is hardly surprising he has done such a fine job.

Almost everyone who regularly reads a daily paper or subscribes to a business magazine recognizes that earnings inequality in the United States has increased without interruption over the past three decades. Household income disparities have risen, too, and the growth in earnings inequality is an important contributor to this rise.

Autor’s paper lucidly explains a crucial fact about the increase in earned income inequality. Earnings disparities did not actually rise uniformly and steadily over time. There have been major changes in the pattern of change in inequality. From the late 1970s up to the early 1990s, earnings inequality increased in almost every dimension. Workers earning the lowest wages saw their earnings fall in relation to median wages. Workers earning wages close to the middle of the distribution saw their earnings fall in comparison to wages at the top. Contrary to a common impression, however, this basic pattern did not continue uninterrupted up to the present day. It came to an end sometime around 1990. Since then earnings inequality has risen at the top—the earners with the highest wages are still pulling away from earners in the middle—but the bottom is not falling further behind the middle. Autor’s Figures 4.2 and 4.3 show a sharp break in the pattern of increasing inequality around 1990. Now low-wage workers are pulling to closer workers in the middle, and have closed part of the earnings gap that opened up in the 1980s.

The shift in the pattern of growing wage inequality naturally has implications for how we think about the demand-side changes that may be contributing to wider earnings inequality. Theories that account for the trends in the 1980s may not do a good job of accounting for developments after 1990. Of course, some theories that helped explain why labor incomes at the very top of the distribution rose so much in the 1980s might do a reasonable job in accounting for wage trends after 1990. However, theories that explained the 1980s decline in relative wages at bottom of the distribution may have to be modified to reflect the fact that wages at the bottom have partly recovered since 1990.

Autor and a variety of his coauthors offer a plausible demand-side theory that accounts for the earnings pattern we have seen since the early 1990s. In recent years advances in information technology and communications methods have significantly increased the demand for the cognitive, decision-making, and interpersonal skills of managers and professionals who are adept at performing abstract, non-routine tasks. The same technical advances have reduced the relative demand for routine clerical, analytical, and mechanical tasks that can now be performed more cheaply with the assistance of inexpensive machines, such as personal computers. Technical advance has been less successful in reducing the need for people who perform some of the economy's least-well paid tasks, many of which require the on-the-spot presence of a manual worker. Autor notes that a variety of low-skill, low-pay, service sector occupations fit this description—health aides, security guards, hospital orderlies, cleaners, and servers. The result is a surge in relative demand for very highly skilled workers who can perform abstract, non-routine tasks, comparative stability in the demand for workers with the lowest skills, and a decline in the relative demand for workers with a middle range of skills.

I do not have any basic disagreement with this theory, which seems to me quite plausible. In addition to the technical and globalization trends that Autor emphasizes, however, I think there has also been a change in wage-setting practices inside of private firms. In the private sector as a whole, the change has occurred partly because unions represent a shrinking percentage of the American workforce. Unions now exercise direct and indirect influence over wages in a narrower and narrower slice of the private labor market. Since unions tended to equalize the wages of workers across skill categories, the reduced influence of unions has tended to weaken the bargaining power of many workers who perform routine, repetitive tasks. Shifts in pay-setting norms within large companies and innovations in executive compensation arrangements have also helped fuel wage growth at the very top of the pay structure. As already noted, this phenomenon has continued up to the present day, and it may continue in the future.

In the remainder of my comments I want to focus on a deep mystery regarding the supply-side response to the demand-side developments Autor describes. In particular, why has the response been so sluggish and small? And why has it been particularly small among American men? The average payoff to post-high-school formal education has risen, but the schooling and skill attainments of U.S. workers, especially men, have increased relatively little, both absolutely and in comparison with trends in other rich industrialized countries.

As noted in Autor's paper, one of the most important contributors to the growth in U.S. wage inequality has been the growing premium that people derive from earning a formal degree after high school. Figure 4.15 shows my own estimates of the earnings premium received by workers for completing a four-year college degree and earning a postcollege degree. The chart displays estimates of the log earnings difference between high school graduates and two groups of workers with higher levels of school attainment, college graduates and workers with at least one postcollege degree. To measure the premium for four-year college degrees and postcollege degrees, I regressed the logarithm of workers' annual labor earnings on age and educational attainment for years between 1968 and 2005 using the Census Bureau's March Current Population Survey files. In order to reduce the sampling variability of the displayed results, estimates shown in Figure 4.15 reflect the centered average of regression coefficients for five successive calendar years. The estimation sample includes full-time, year-round workers between 25 and 64 years old who have a valid report of their annual labor income, including both wages and net self-employment earnings.[1]

The top and bottom panels of Figure 4.15 show sizeable increases in the earnings premium enjoyed by college and postcollege degree holders during much of the period after 1980. Female degree holders saw their

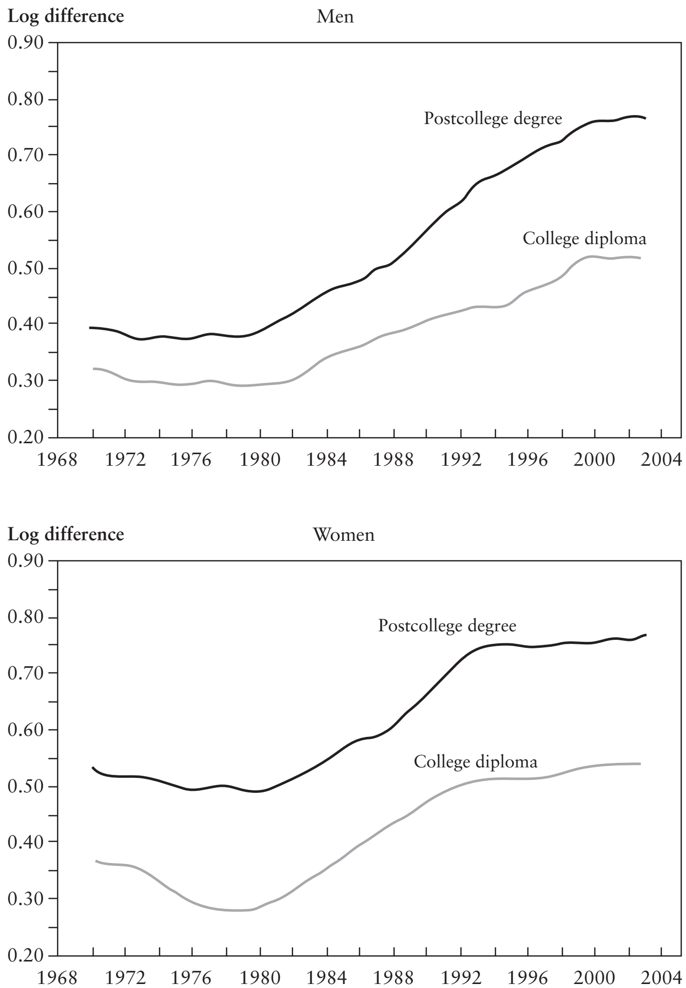

Figure 4.15
U.S. Trends in Earnings Premium for a Four-Year College Degree versus a High School Diploma, 1968–2005
Source: Author's tabulations of 1969–2006 March Current Population Survey files.
Note: The figure shows trends in the log pay differential between earnings of the indicated educational group and U.S. workers of the same sex who have a high school diploma. To reduce sampling variability, the chart shows 5-year centered moving averages of the regression coefficients.

educational pay premium rise substantially between 1980 and 1992, but their gains since 1992 have been very small; see Figure 4.15's lower panel. The increase in the educational pay premium persisted over more years for male degree holders, but their gains appear to have slowed or stopped in the late 1990s, as shown in the top panel of Figure 4.15. Since four-year college completion has become more common among working-age Americans, the rise in the payoff to advanced schooling has occurred against a backdrop of an increasing relative supply of well-educated workers. This development leads many labor economists to infer that the rising earnings premium for higher education must have signaled a rise in the relative demand for highly educated workers. The fact that the earnings premium for college and postcollege degrees stopped increasing in the middle or late 1990s suggests that some of the factors pushing up relative demand for highly educated workers slowed or the availability of college-educated workers increased.

Figure 4.16 shows estimates of the earnings penalty suffered by U.S. workers if they have failed to complete secondary school. The estimates were obtained using the same method and with the same sample described above. These results show that the pay differential between high school dropouts and graduates widened between 1980 and the late 1990s, but the differential has not widened much in recent years.

Now we come to the puzzle. Why was the supply-side response to these relative wage changes so sluggish and small? Figure 4.17 shows the trend in college completion rates in the U.S. population between the ages 25 and 34 years. This group is comprised of young adults who have just attained an age where we should expect that they have completed their college education. The broken line in the chart indicates college completion rates among women; the solid line shows the same trends among men. The financial reward for completing a four-year college degree rose steadily and strongly from 1979 to 2000, but college completion rates rose relatively slowly for women in the 1980s and actually declined among 25–34 year-old men in the same decade. College completion rates for young men and women improved in the 1990s. Nonetheless, the college completion rate for men is about the same in 2006 as it was in the late 1970s, when the pay premium for a four-year college degree was considerably smaller than it is today; see Figure 4.15. Young

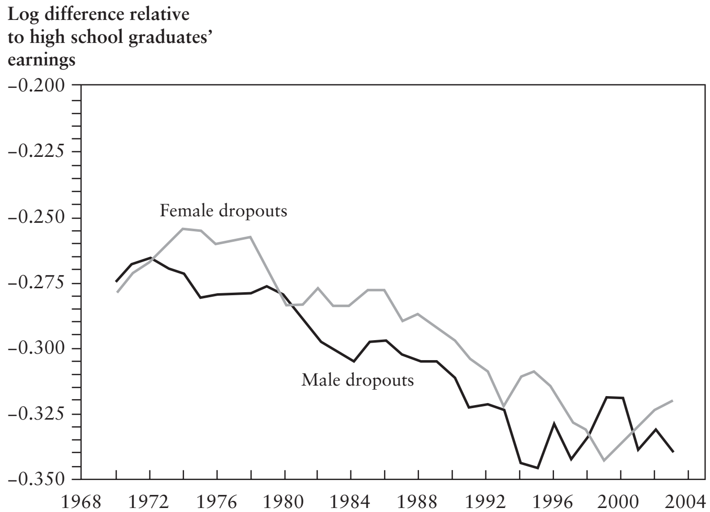

Figure 4.16
U.S. Trends in the Earnings Penalty for Failure to Complete High School, 1968–2005
Source: Author's tabulations of 1969–2006 March Current Population Survey files.
Note: The figure shows trends in the log pay differential between earnings of U.S. high school dropouts and workers of the same sex who have a high school diploma. The sample consists of full-time, year-round workers. To reduce sampling variability, the chart shows 5-year centered moving averages of the regression coefficients.

women apparently pay closer attention to wage trends described in the daily papers and business magazines. Today, college completion rates for women are appreciably higher than in the late 1970s. Their completion rates are, in fact, currently higher than young men's college completion rates. We cannot reject the hypothesis that young women are somewhat smarter or more forward-looking than young men. Even among women the trends shown in Figure 4.17 represent a bit of a mystery. The pay premium for a four-year college degree and a postcollege degree rose more strongly between 1980 and 1992 than it did in earlier or later years, as shown in the lower panel of Figure 4.15. Yet the trend toward higher college completion rates actually decelerated in that period. Even young women appear slow in responding to price signals in the job market.

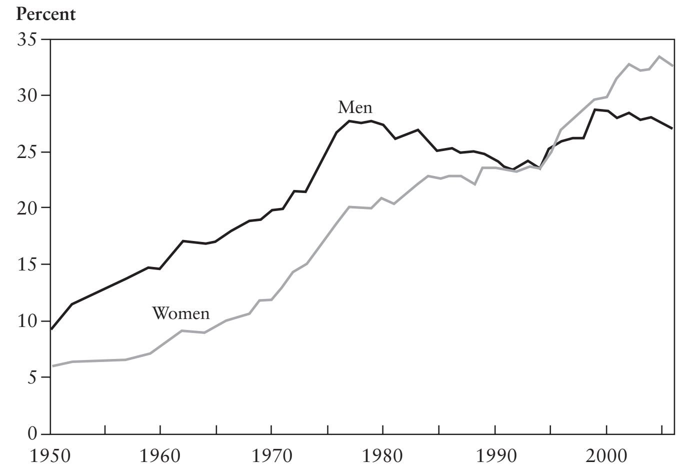

Figure 4.17
College Completion Rates of Americans Aged 25 to 34 Years, 1950–2006
Source: U.S. Census Bureau.

What about college completion rates among prime-age workers? Figure 4.18 shows the rates of four-year college completion among 35–54 year-olds in the five and a half decades after 1950. Prime-age males reached a peak rate of college completion in the late 1980s. There has been essentially no rise in prime-age men's college completion since that time. Of course, college attainment in this population mainly reflects educational decisions that were made at least a decade, and sometimes up to three decades, earlier. Very few 45-year-old men think seriously about enrolling in college. This middle-aged group is not a population segment where we would expect to see an instantaneous response to a bigger college pay premium. The college completion rate among prime-age women has risen much more steadily than the comparable rate among men. This probably reflects the fact that a much bigger percentage of women now expects to earn a large fraction of their families' total income over the course of their careers, raising the importance of obtaining a good educational credential that commands a premium in the labor market.

The educational decisions that should respond fastest to changes in wage signals are those made by adolescents and young adults between 16 and 24 years of age. In most states 16 years is the oldest age for which

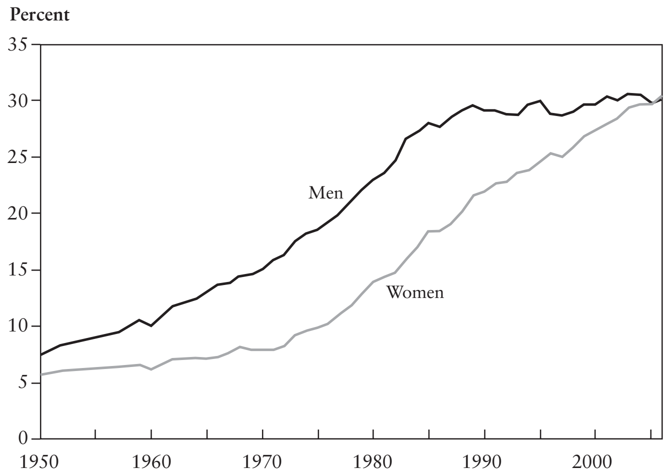

Figure 4.18
College Completion Rates of Americans Aged 35 to 54 Years, 1950–2006
Source: U.S. Census Bureau.

school attendance among youth is compulsory. Few people between 16 and 24 years of age have to enroll in school if they do not wish to attend. Figure 4.19 shows trends in the number of years that young people are enrolled in school between the ages of 16 and 24 years. The Census Bureau conducts an annual household survey in October asking about school enrollment. The estimates displayed in Figure 4.19 show the total number of Octobers between ages 16 and 24 years that members of successive birth cohorts have spent as enrollees in secondary school, college, or university. Someone enrolled in each October would have been enrolled for a total of nine years. The cumulative number of enrollment years rose from 2.9 years for 24-year-old men in 1955 to 4.5 years for 24-year-old men attaining in 1971. For 24-year-old men in the first half of the 1980s, the cumulative number of enrollment years fell below 4.0 years. From 1986 to 1998 the number of enrollment years increased, but for male cohorts attaining age 24 in years after 1998, the number of enrollment years has stagnated or declined slightly. In 2005 24-year-old young men accumulated only slightly more years of school enrollment than 24-year old men in the early 1970s. These enrollment trends seem

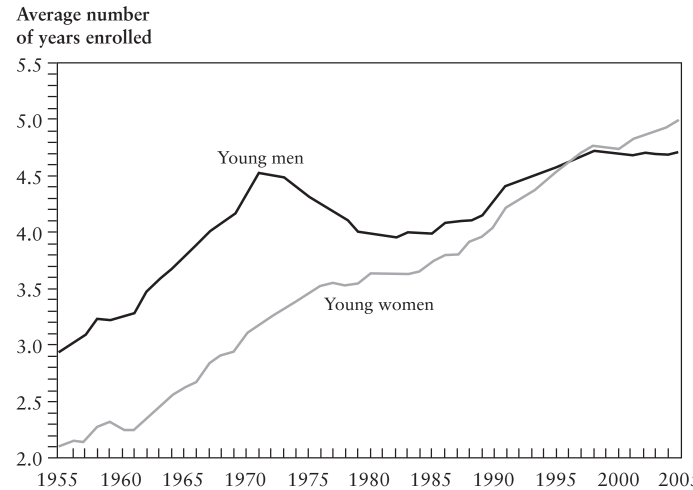

Figure 4.19
U.S. Trends in Educational Enrollment for Americans Aged 16 to 24 Years, 1955–2006
Source: U.S. Census Bureau.

puzzling in view of the fact that the male pay premium for completing a four-year college degree increased from 28 percent in 1980 to 51 percent in the late 1990s. The pay premium for obtaining a postcollege degree increased from 39 percent to 76 percent over the same period. Tuition, one component of college costs, increased over that period. However, another big component of enrollment costs fell— the opportunity cost of being enrolled in school. When the real wages of male high school dropouts and high school graduates declined, the foregone earnings of young men enrolled in school also declined.

The years young U.S. women spend enrolled in school have increased more steadily over time. Since 1997, 24-year-old women have accumulated more years of schooling than 24-year-old men. Female enrollment rates, however, do not show a clear pattern of response to the rise in the pay premium commanded by a four-year college degree. Women's enrollment rates rose rapidly between the 1960s and early 1980s, when the female college premium shrank, and these rates did not rise any faster when the college pay premium soared after the early 1980s.

It is worth comparing trends in school attainment in the United States with educational trends in other rich countries. Tertiary school completion rates have been calculated by the Organization of Economic Cooperation and Development (OECD) for a number of OECD-member countries. Tertiary schooling is defined as educational attainment that goes beyond a secondary degree but falls short of four-year college completion. Figure 4.20 contains results for 22 OECD countries. Each square indicates the tertiary completion rate among people who were between 45 and 54 years old in 2003. Each triangle indicates the rate of tertiary completion among people who were between 25 and 34 years old in the same year. By comparing the two tertiary completion rates, we have a rough indicator of the trend in tertiary completion in each country.

This comparison suggests the United States has seen little trend change in its tertiary completion rate over the past 20 years. Note that this estimate combines the completion rates of both men and women. There are a couple of other countries where tertiary completion rates have also been stagnant, notably New Zealand and Germany. By and large, however, most OECD countries have seen increases in their tertiary completion rate. In many countries, the gains have been substantial. Note that in the older age group, adults between 45 and 54 years of age, the United States has the highest tertiary completion rate of any of the 22 countries. In the younger age group, people between 25 and 34 years of age, the United States ranks only eighth out of the 22 countries for tertiary completion. Among these countries, the United States may have experienced the biggest increase in the gross financial payoff to obtaining a postsecondary educational degree. The wage premium for attainment of a postsecondary degree, meaning a four-year college degree or a postcollege degree, was typically larger in the United States than it was in other industrial countries in 1970s, and the premium increased more in the United States than it did in most other countries after 1979. In the face of bigger increases in the college pay premium, why have tertiary completion rates remained stagnant in the United States?

One explanation is the country's high rate of immigration. Although immigrants have a college graduation rate that is close to that of native-born Americans, immigrants also have exceptionally low rates of high school completion. They have much lower high school completion rates

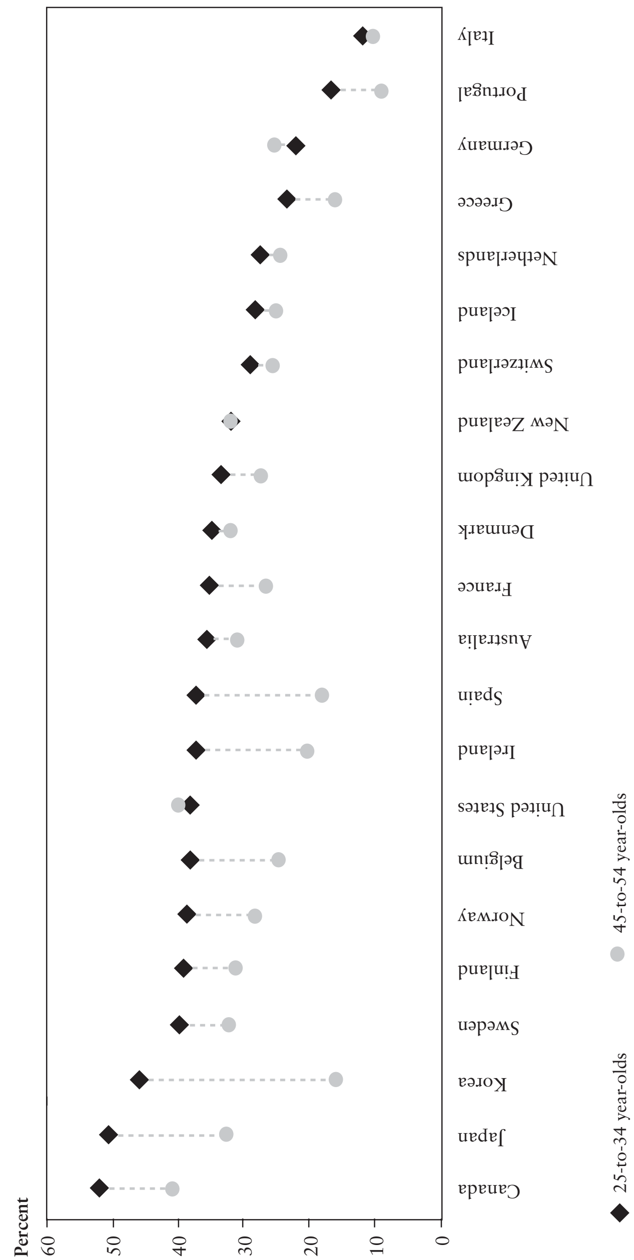

Figure 4.20
Trends in Tertiary School Completion Rates in 22 OECD Countries, 2003
Source: OECD, *Education at a Glance, 2005* (Paris: OECD, 2005). Chart A1.3.
Note: For Iceland, the Netherlands, and Italy, data are from 2002 rather than 2003. Tertiary school completion is defined as ". . . the population that has attained tertiary-type B education or tertiary-type A and advanced research programmes."

than native-born residents who are the same age, and many children of immigrants fail to enroll in or to complete college. Since immigrants and immigrants' children are a rising percentage of the U.S. resident population, the trends shown in Figures 4.17 through 4.20 show slower educational progress than we would see if U.S. immigration rates were lower or if admitted immigrants had more schooling.

Another explanation for Americans' slow educational progress is that school institutions have captured part of the increase in the educational pay premium. This has been accomplished by charging higher prices, mainly for tuition and fees. Most economists recognize that this cost increase has been partly or entirely offset by the declining opportunity cost of attending college. As young people's wages, especially young men's wages, have declined, their cost of delaying entry into the workforce has fallen. Nonetheless, a stubbornly high percentage of young American men has failed to attend or complete college.

Another possible explanation is a rise in the perceived risk in the payoff of attending a postsecondary institution. The college pay premium has increased on average, but so too has the variance around the average graduate's pay. There may be a bigger risk that workers with just one or two years of college will earn a lower wage than the average wage earned by a high school graduate. For instance, a high-school graduate who works as a plumber may well earn more than a community-college graduate who might work as a store clerk. However, it would require a very strong degree of risk aversion for far-sighted workers to remain out of college as a result of the increased uncertainty of college graduates' pay.

Why are college enrollment rates rising in other rich countries but remaining relatively constant in the United States? One possibility is that U.S. teenagers and young adults do not know how to perform the benefit-cost calculations that would inform them of the financial advantages of college attendance. Compulsory schooling laws provide some protection against the shortsightedness of 15-year-olds. State laws oblige 15-year-olds to attend school. Among people between 16 and 24 years of age, the main protection against short-sighted decisions is the influence of a rational and far-sighted parent. Upper middle-class and middle-class parents have many resources with which to bribe their youngsters. Some

parents pay for the full cost of a child's tuition and college room and board, and others pay a substantial part of the charges that are not covered by financial aid. A great deal of evidence suggests these parental bribes are successful in persuading middle-income and affluent children to attend college. Recent increases in college enrollment have been concentrated among young adults in the middle class and especially in the upper middle class.[2] In contrast, poorer parents have fewer resources to influence their children's secondary and postsecondary educational decisions. Many low-income students cannot borrow enough money or work enough hours to pay their college bills while simultaneously maintaining an acceptable grade point average. For students who do not particularly enjoy schoolwork, the decision about whether to attend college may depend on whether their parents bribe them to attend. When returns to higher education rise, far-sighted parents will want their children to attend college. But while affluent parents can influence their children's decisions by offering to pay, poor parents cannot. As a result, affluent students respond to changes in the long-term benefits of obtaining a college education, while poor students respond mainly to changes in the short-term costs of attending college.

An explanation for the divergence between educational attainment trends in the United States and other industrial countries may be that U.S. postsecondary institutions charge much higher fees than counterpart institutions in other rich countries. For that reason, the short-term cost of attending college may loom larger in the decisions made by adolescents and their parents. Most rich countries impose low charges on the students who qualify for admission to college, and a few routinely provide generous subsidies to cover the living expenses of enrolled students. It is of course possible in the United States for low- and moderate-income students to obtain generous financial aid or to enroll in low-cost public institutions, at least for the first two years of college. But many eligible students may not apply to college if they do not realize how much aid is available. Others do not apply because the short-term costs of attending seem large in relation to the distant and uncertain income gains they may achieve as a college graduate. While adolescents and young adults may be equally short-sighted and ill-informed in all industrial countries, the United States is unusual in imposing such high and erratic direct costs on students who may enroll in college. The evidence in Autor's paper and in Figures 4.17 through 4.20 strongly suggests that the supply response to bigger college pay premiums in the United States has been too sluggish and too small to bring the college premium back to its level in the 1960s and 1970s.

Notes

1. The basic time trends are similar if I perform regressions based on all workers who earn at least $1 per year in wages or net self-employment income. In order to offset the effects of year-to-year changes in the Census Bureau's top-coding procedures, I top-coded earnings in every year using a simple and uniform procedure. Reported earnings that exceeded the 97th percentile of male earnings in a given year were recoded to the 97th percentile value for male earners, and earnings reports that exceeded the 99th percentile of female earnings in a given year were recoded to the 99th percentile value for female earners. This procedure means that the estimated education premiums do not capture the full earnings advantage enjoyed by well-educated earners in the top 3 percent of the male earnings distribution and in the top 1 percent of the female distribution. Thus, the estimates almost certainly understate the increase in the education premium, especially for men.

2. David Ellwood and Thomas Kane, "Who Is Getting A College Education? Family Background and the Growing Gaps in Enrollment," in Sheldon Danziger and Jane Waldfogel, eds., *Securing the Future* (New York: Russell Sage, 2000).

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The Cyclical Sensitivity of Labor Supply